



# Corrosion Prevention and Control Planning Guidebook for Military Systems and Equipment

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The Office of Corrosion Policy and Oversight oversees and coordinates efforts throughout the Department of Defense to prevent and mitigate corrosion of the military equipment and infrastructure of the Department.

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## Preface

The Department of Defense (DoD) recognizes that Corrosion Prevention and Control (CPC) planning is critical to acquisition program success (see the Defense Acquisition Guidebook (DAG, Section 4.3.18.5). The need for CPC planning is paramount:

- **It Is In Law**—CPC planning is mandated in 10 U.S.C. 2228 and must be part of the 10 U.S.C. 2366(b) certification;
- **It Is In Policy**—CPC planning is required in DoD Directive (DODD) 5000.01, DoD Instruction (DODI) 5000.02, DODI 5000.67, and other policy; and
- **It Is Costly Not To**—Approximately \$23 billion annually goes into maintenance due to corrosion, which is almost 25% of every maintenance dollar. Availability and safety of systems/equipment is also impacted significantly by corrosion.

The purpose of addressing CPC planning on programs is to help ensure CPC is achieved at every stage in the lifecycle and as early in the cycle as possible, along with communicating to all stakeholders the process for managing CPC throughout the entire lifecycle of a program. It is important to recognize CPC planning involves the participation of many people, not just the corrosion specialists. It also includes Program Management, Systems Engineering, Life Cycle Logistics, Test and Evaluation, Contracting, and Cost Estimating and Budget. Material sustainment is difficult, if not impossible, to be cost-effectively reengineered into a fielded systems. Therefore, early planning is paramount.

The purpose of this Guidebook is to assist DoD and contractor Program Offices (POs), Program Managers (PMs), and Integrated Product Teams (IPTs) in effectively managing corrosion during the entire acquisition process, including sustainment. It is one part of the body of knowledge provided in several policies and other guidance. The goal of this Guidebook is to assist in reducing ownership costs and increasing system availability through improved CPC planning and execution of an effective CPC strategy. This Guidebook contains baseline information and explanation for establishing a well-structured CPC program. The management concepts and ideas presented in this Guidebook encourage use of time-tested practices and suggest a process to address a CPC program without prescribing specific methods or tools.

The information presented within this Guidebook is developed from best practice lessons learned. PMs and other acquisition professionals are encouraged to apply the fundamentals presented in this Guidebook to all acquisition efforts, both large and small, and to all elements of a program (system, subsystem, hardware, components, support equipment, automatic test systems, training systems, information technology, spares, and repair parts). CPC is a fundamental management tool for effectively addressing and reducing corrosion. POs/PMs should tailor their approach to fit their acquisition program, statutory requirements, and lifecycle phase. This Guidebook applies to all DoD Components and should be used in conjunction with related directives, instructions, policy memoranda, or regulations issued to implement mandatory requirements.

Related online corrosion training is also available. Defense Acquisition University (DAU) Corrosion Prevention and Control Overview Continuous Learning Module (key word:

“corrosion”/course number CLM 038) is found on the DAU website at <http://www.dau.mil>. Other training materials are available at [www.corrdefense.org](http://www.corrdefense.org) and [www.corrconnect.org](http://www.corrconnect.org). There may be other training available through the Corrosion Control and Prevention Executive (CCPE).

The primary responsibility for this Guidebook resides with the Office of DoD Corrosion Policy and Oversight (CPO) within the Office of the Secretary of Defense (OSD). The CPO will develop and coordinate updates to this Guidebook as required, based on policy changes and customer feedback. To provide feedback to this document, contact:

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## EXECUTIVE OVERVIEW

Corrosion is not simply a sustainment concern; it needs to be addressed from program/system/equipment inception to disposal (i.e., “cradle to grave”). Corrosion Prevention and Control (CPC) at the early stages in a system development can result in a reduction of Total Ownership Cost (TOC). In addition, conducting effective and timely CPC planning is not as elusive and difficult as it may seem.

What is considered corrosion? According to 10 U.S.C. 2228, corrosion is the deterioration of a material or its properties due to a reaction of that material with its chemical environment. Corrosion is far more widespread and detrimental than merely rust, and much more needs to be considered. This includes polymers, composites, ceramic, and alloys.

CPC is the rigorous application of management principles, engineering design and analysis, quality assurance (QA), non-destructive inspection (NDI), manufacturing, operations, and support technologies and practices to prevent the start of corrosion, avoid functional impairment due to corrosion, and define processes for the tracking and repair of corrosion problems. Although not required as an element (e.g., Logistics, Test and Evaluation (T&E), Manpower, Personnel, and Training (MP&T) of DoD Risk Management (RM), incorporating CPC as part of your RM is an effective way to provide tracking and mitigation of corrosion for the system/equipment.

The content of this Guidebook was developed from broad and in-depth military and industry experience regarding the protection of systems/equipment from corrosion and its effects. This Guidebook provides:

- An overview of tools, techniques, and best practices for evaluating and implementing CPC in materials and processes;
- A discussion of material selection practices and finish treatments that positively impact the corrosion resistance of a system/equipment during all acquisition phases;
- Guidance on program management that can be implemented in organizations to address corrosion issues and develop CPC plans and that describes requirements and methods for:
  - Establishing and managing a Corrosion Prevention Team (CPT) (or equivalent functioning activity) that is appropriately integrated into all Integrated Product Teams (IPTs); and
  - Developing and implementing a Corrosion Prevention and Control Plan (CPCP).

This Guidebook is designed to assist the acquisition workforce and the system procuring activities in the development and execution of an effective CPC strategy. This Guidebook provides suggestions to the acquisition and sustainment workforce to affect and improve CPC planning. It focuses on these keys to success:

- Good planning and effective execution;
- Proper timing, especially focusing on the acquisition phase of the program;
- Proper resources and focus, especially the necessary funding and expertise;
- Contracting, especially influencing the Request for Proposal (RFP) and its contents; and

- Integration of CPC planning and execution into other mainstream acquisition processes, such as program management, systems engineering, life cycle logistics, T&E, contracting, and budgeting.

To make this Guidebook easy to use and relevant to individuals who have to plan and execute a CPC strategy, the five enclosures target the acquisition phases of a program/system/equipment. Further, each phase-focused enclosure is broken down into six key functional areas:

- Management;
- Systems Engineering;
- Life Cycle Logistics;
- Test & Evaluation;
- Contracting; and
- Cost Estimating and Budget.

Enclosures 1–5 are meant to provide guidance to acquisition workforce personnel with considerations in planning and executing a CPC strategy. This planning should be documented for the program lifecycle in the CPCP and maintained as a living document. While the near-term events and activities of the program are better known and more detail can be developed, long-term planning must also be addressed and contained within the CPCP, even if with less detail and certainty. As the PO personnel use these enclosures in CPC planning, the headings used in the enclosures can also be used as a guide for topical areas to address within the CPCP. None of these topical areas are required by any format. The program may describe its CPC strategy and plan as deemed necessary by the PO/PM team. The PO/PM should exercise due diligence in development of a viable and effective CPCP.

We encourage all acquisition personnel to become familiar with each functional area in each of the phases but to also focus on their functional area within their pertinent phase or approaching milestone to get a feel for the best methods to conduct CPC planning. We encourage all to become familiar with the CPC planning timeline and when CPC actions are necessary during the acquisition timeline. These will be a key to performing full lifecycle CPC planning and execution. Keeping the bigger picture in mind is important in the daily execution of a CPC strategy. Everyone on the team should be involved in executing the best CPC strategy possible and make improvements when needed. When considering any characteristic of a program acquisition, a balance of cost, schedule, performance, and risk is necessary, and CPC planning is important to and can positively affect that balance.

This Guidebook does not provide a format for a CPCP. Each acquisition program is different, and the CPCP should be developed to fit the unique structure and characteristics of that program. This Guidebook provides insight and guidance for developing a CPCP.

Major Automated Information System (MAIS) programs are required to provide CPC planning through the lifecycle of the program and address CPC in the Systems Engineering Plan (SEP) and at Milestones B and C reflected in the program/system's CPCP. Some guidance on the depth of planning required/expected for MAIS programs is offered in Appendix IV. For non-MAIS IT programs, CPC planning may be advisable, although a full CPCP might not be warranted. The

non-MAIS IT programs should still consider the intent of the MAIS guidance in Appendix IV to determine if more robust CPC planning should be accomplished.

While the use of commercial off-the-shelf (COTS), government off-the-shelf (GOTS), NDI, or derivatives of these acquisition strategies may benefit the acquisition program, it can complicate the CPC planning process and introduce risk to long-term sustainment. Exercising due diligence on CPC planning on these types of products is critical. Regardless of the acquisition strategy, CPC planning and execution principles apply.

For additional help and resources, go to [www.corrdefense.org](http://www.corrdefense.org) and [www.corrconnect.com](http://www.corrconnect.com).

## INTRODUCTION

### 1.0 Purpose

Those in the DoD acquisition workforce greatly influence DoD's corrosion-related cost, safety, and availability during the acquisition of systems and infrastructure. This Guidebook provides the workforce with guidance for developing and implementing a Corrosion Prevention and Control (CPC) strategy for DoD program/systems/equipment and supporting infrastructure. This Guidebook includes support for corrosion-related policy, management planning, and technical design considerations that should be addressed for development of a viable design. In addition, this Guidebook should help to identify materials, processes, techniques, and tasks required to develop and integrate an effective CPC strategy during all phases of a DoD acquisition.

This Guidebook supports implementation of CPC planning within 10 U.S.C. 2228 and 2366, DODI 5000.02, and DODI 5000.67. Following the guidance provided, in conjunction with applicable program and technical documentation, will assure CPC is considered appropriately in the acquisition and lifecycle management for a DoD program/system/equipment.

Numerous corrosion-related definitions are provided as Appendix III, but these three are important to understand early in this Guidebook:

- **Corrosion Prevention and Control (CPC).** The processes and techniques that can be implemented to prevent and control corrosion from impacting the availability, cost, and safety of Military Equipment.
- **Corrosion Prevention and Control Planning.** Consists of planning for and establishing 1) a management structure for CPC, and 2) the technical considerations and requirements in order to implement an effective CPC regime throughout the life cycle of a program. CPC planning must include program management, engineering (including systems engineering), life cycle logistics, test and evaluation, budget/funding and contracting. A CPC Plan (CPCP) formally documents the CPC planning and execution, and is updated, refined and matured as the program proceeds through the life cycle phases.
- **Corrosion Prevention and Control Plan (CPCP).** A formal plan developed and implemented by the Program Manager (PM) to prevent and control corrosion from impacting the availability, cost, and safety of Military Equipment.

This Guidebook is not intended to provide CPC planning guidance for facilities and infrastructure (F&I); separate guidance applies for F&I. However, this Guidebook does address those F&I requirements that are part of the CPC planning and solution on a system/equipment acquisition (such as a strip and repaint facility).

### 2.0 Requirement

Title 10 U.S.C. 2228 requires DoD to develop and implement a long-term strategy to address the corrosion of its equipment and infrastructure. A key element of the DoD CPC strategy is programmatic and technical guidance provided in this Guidebook. The importance of both acquisition and sustainment (see Figure 1), is that 60–80% of a program/system/equipment lifecycle costs occur in the sustainment phase. However, most of the decisions (e.g., material selection, component reliability, and designed maintainability) are determined during the acquisition phase.

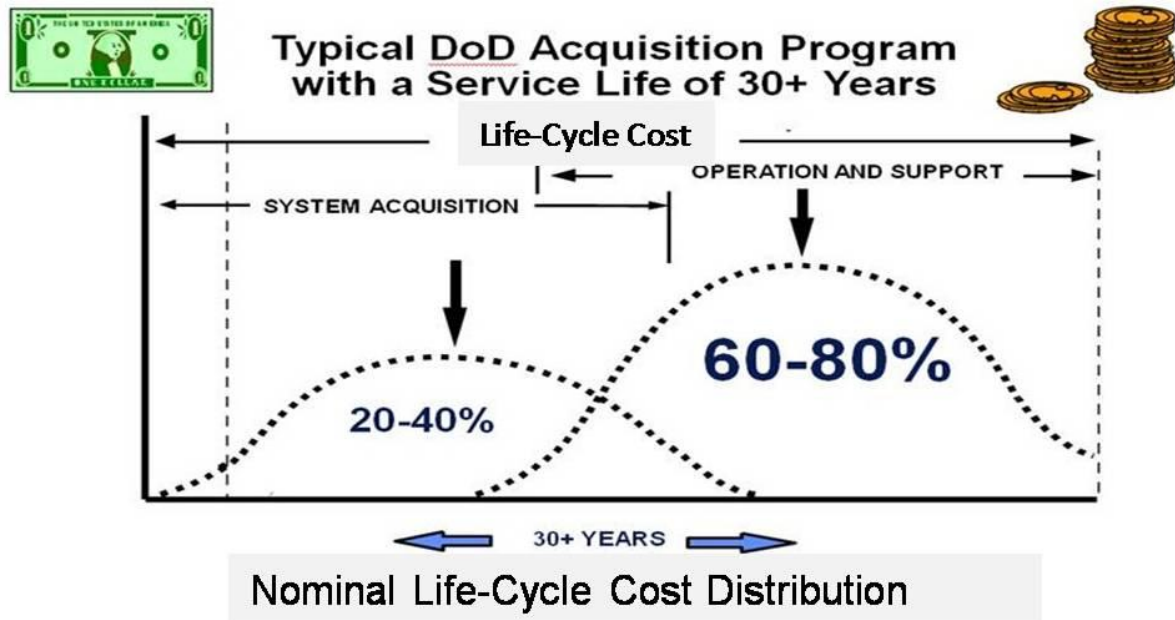


Figure 1: Acquisition and Sustainment Phases

### 3.0 Background

The term corrosion is defined as the deterioration of a material or its properties due to a reaction of that material with its chemical environment. Other key definitions are as follows:

- CPC is the rigorous application of engineering design and analysis, quality assurance (QA), non-destructive inspection (NDI), manufacturing, operations, and support technologies to prevent the start of corrosion, avoid functional impairment due to corrosion, and define processes for the tracking and repair of corrosion problems.
- Integrated Product Teams (IPTs) are an integral part of the defense acquisition oversight and review process. An IPT is a multifunctional team assembled around a product or service and responsible for advising the Program Office (PO), Program Manager (PM), Project Leader, or the Milestone Decision Authority (MDA) on cost, schedule, and performance of that product. There are three types of IPTs: Program IPTs, Working-Level IPTs (WIPTs), and Overarching IPTs (OIPTs).
- The Defense Acquisition Board (DAB) advises the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) on critical acquisition decisions. DAB reviews focus on key principles such as interoperability, time-phased requirements related to an evolutionary approach, and demonstrated technical maturity.

The DoD acquires, operates, and maintains a vast array of physical assets, ranging from aircraft, ships, ground combat vehicles, and material, as well as wharves, buildings, and other

infrastructure. These assets are subject to degradation due to corrosion, with specific effects in the following areas:

- **Safety**—A number of systems/equipment and F&I mishaps have been attributed to the effects of corrosion. For example, corrosion-related structural cracking has resulted in catastrophic failure, and corroded electrical contacts have contributed to mishaps.
- **Availability**—Systems and equipment are routinely unavailable due to corrosion deficiencies.
- **Financial**—Approximately 25% of all systems/equipment and facility maintenance is attributable to corrosion, costing DoD more than \$20 billion annually.

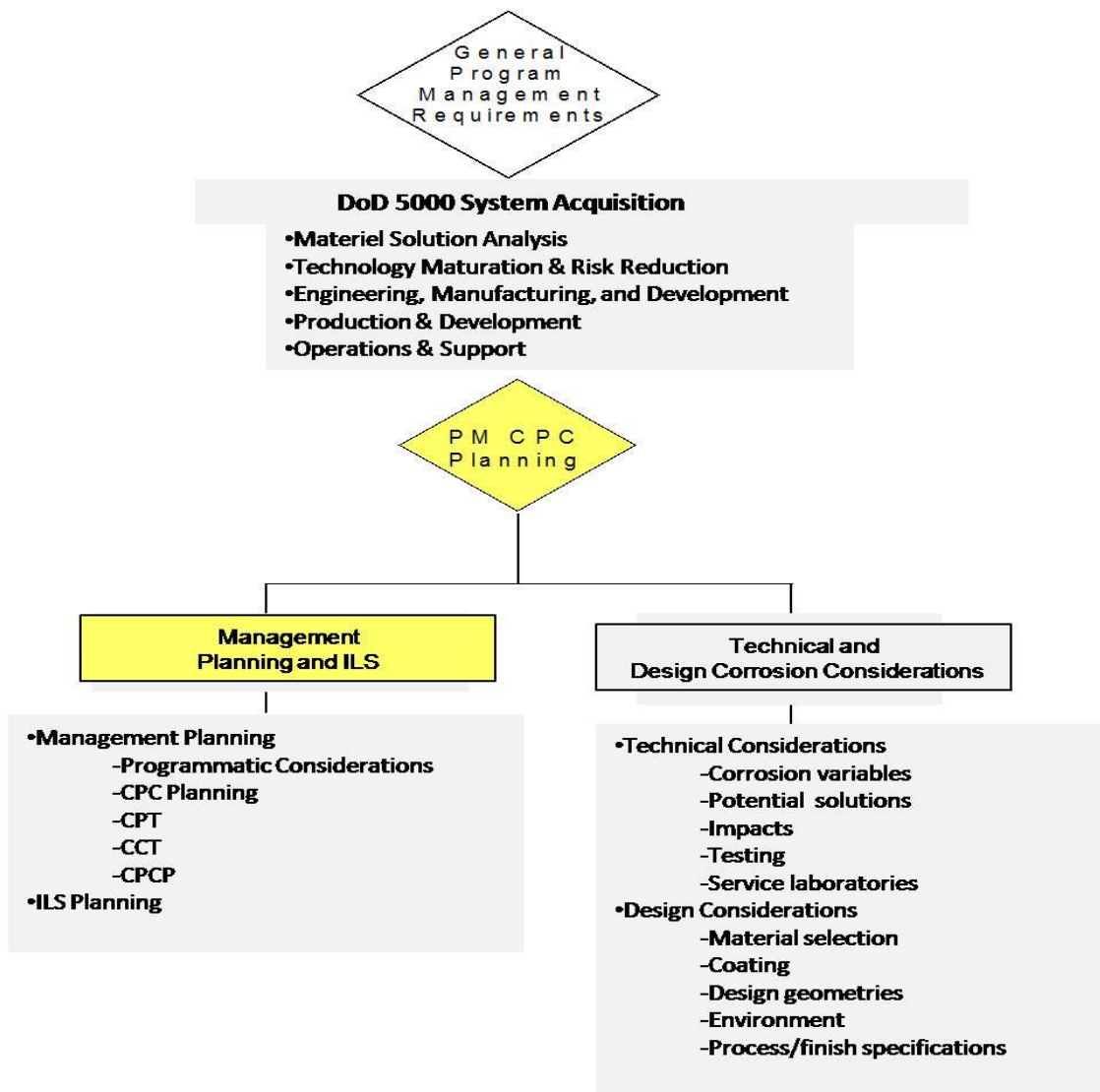
DoD has a long history of CPC. The Department has been a leader in many areas of research, ranging from understanding the fundamentals of corrosion to applying advanced materials, coatings, inhibitors, and cathodic protection for corrosion control over many years, well before the DoD Corrosion Policy and Oversight Office was created. However, it also has very special corrosion-related challenges:

- DoD's assets are getting older. The current expected (although often not planned) service lives of some aircraft, missiles, ships, and infrastructure are much longer than any comparable commercial assets. To perform its mission, the Department must train, fight, and sustain its systems and equipment in all environments, some of which are among the most severely corrosive on earth.
- DoD has unique corrosion-related issues. For example, many coatings used on vehicles and other assets are formulated to perform a special function, such as resistance to chemical agents or maintaining a low radar signature. Corrosion is, at best, a secondary consideration. According to Department of Defense Directive (DODD) 5000.01 (The Defense Acquisition System), when implementing performance-based logistics strategies, tradeoff decisions involving cost, useful service, and effectiveness shall consider corrosion prevention and mitigation. DODI 5000.02 (Operation of the Defense Acquisition System) further requires CPC planning throughout the lifecycle of a program, system/equipment and specifically mandates the approval of a CPCP at Milestone B and C for Acquisition Category (ACAT) I programs.

#### **4.0 Overview of Corrosion Prevention and Control Planning**

PMs and supporting activities should consider CPC as a key issue in design, procurement, and maintaining DoD systems, equipment and their associated facilities. As shown in Figure 2, there are two primary aspects of CPC planning and implementation:

- Management of the planning and implementation; and
- Technical and design considerations (e.g., requirements and tradeoffs) that lead to viable CPC planning and implementation.



*Figure 2: The Corrosion Planning Model – Management Planning and Integrated Logistics Support (ILS)*

Although planning and implementation methods and procedures vary by system/equipment and responsible service or agency, it is critical to maintain the intent of these two requirements.

Section 4.1 addresses the Management aspects of CPC planning and implementation, and Section 4.2 addresses the Technical and Design Considerations.

#### **4.1 General Program Management Requirements**

DoD policy requires POs/PMs to accomplish corrosion-related planning during early acquisition efforts. Management for equipment CPC planning specifically applies to programs, systems, and equipment covered by the DoD 5000-series publications (see Figure 3). The need for viable CPC planning is critical to program success. Effective and viable CPC planning should be smoothly and seamlessly integrated with the overall acquisition planning. The initial phases of the

acquisition cycle should consider the effects of corrosion on the program, system, and equipment and should be reflected in the required programmatic documentation. A CPCP describes how a particular program will implement CPC planning.

#### 4.1.1 Systems Acquisition Community

As stated in DODD 5000.01, the primary objective of Defense acquisition is to acquire quality products that satisfy user needs with measurable improvements to mission capability and operational support, in a timely manner, and at a fair and reasonable price. Good CPC planning and practices applied appropriately improve the safety, availability, and lifecycle cost of systems and equipment.

#### 4.1.2 Management of Corrosion Prevention and Control

This section provides guidance on how to establish a management structure for CPC. The key elements to establishing this management structure are the development of a Corrosion Prevention Team (CPT) or effective equivalent and documenting the management and technical approach in a CPCP. Understanding that the management and technical approach will evolve throughout the lifecycle, Figure 3 provides notional actions for development of a CPT and CPC planning within the acquisition process.

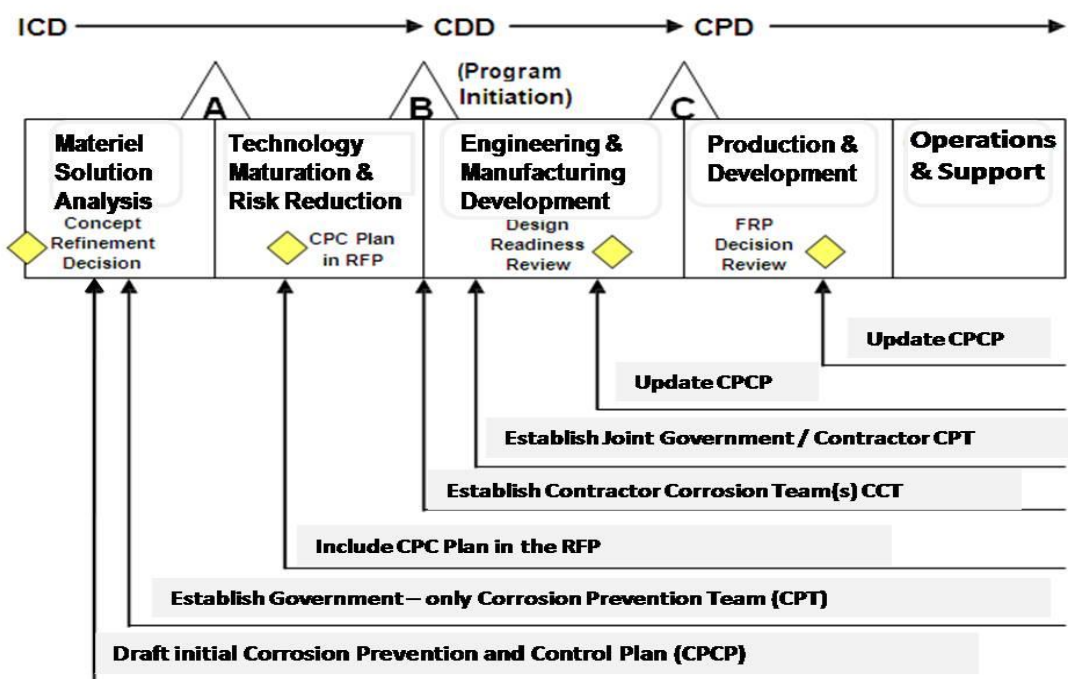


Figure 3: The Defense Acquisition Process and CPC Planning

Many different approaches can be instituted to ensure effective management of the CPC strategy. Establishment of a CPT is one such approach. While other approaches could be acceptable, the CPT is preferred and described below.

#### **4.1.3 Corrosion Prevention and Control Planning**

CPC planning is iterative for the life of the program. CPC planning should begin long before a Request for Proposal (RFP) is released. The initial CPC requirements should be developed early to assure the RFP includes the acquisition program's corrosion planning needs. The initial CPC planning also guides the initial performance specification development. CPC planning consists of the following:

- Establishment of the CPT, which, along with the Contractor Corrosion Team (CCT), guides the direction of CPC planning;
- Documentation that implements and reflects the CPC planning;
- CPC considerations included in development of source selection criteria;
- Requiring the contractor(s) to provide sufficient evidence/documentation to show that appropriate CPC planning can be effectively executed; a Contractor CPCP is encouraged as a deliverable; and
- Actual design, manufacture or construction, testing, and support of the system/equipment.

Procurement of commercial off-the-shelf (COTS) systems or equipment does not obviate the requirement for effective CPC planning.

If during CPC planning facilities are identified to support the corrosion program, ensure that the appropriate F&I offices are included.

##### **4.1.3.1 Corrosion Prevention and Control Plan**

The CPCP is expected to be a lifecycle document and should:

- Define CPC requirements; and
- Establish the management structure to be used for the system and equipment being designed, procured, and maintained.

The purpose of a CPCP is to:

- Set up the CPC strategy or a project management approach;
- Assure CPC planning occurs on all Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel and Facilities (DOTMLPF) goals, objectives, and considerations;
- Document corrosion-related design needs and considerations;
- Identify materials and corrosion control methods for use in the manufacture of the system and equipment;
- Assure support for the system and equipment is planned and will be in place; and
- Identify and secure contractual and funding needs.

The initial draft of the CPCP should be completed as early in a program as possible but is mandatory before an ACAT I program's Milestone B. The plan should describe the specific anticipated CPC measures to be implemented. The CPCP should be updated and maintained by the CPT and/or PM or project manager and revised as required to properly record changes to

materials and processes being used for CPC. Through design studies, analysis of failure reports, and inspections, data should be collected for analyses of required revisions to this document. Copies of the major revisions to the document should be formally submitted to the Defense Technical Information Center (DTIC) so the CPT's accomplishments are preserved and future programs can benefit from legacy knowledge as they prepare their respective CPCPs. Consider referring to the DoD Cost of Corrosion Studies available at [www.corrdefense.org](http://www.corrdefense.org).

At a minimum and as required, the CPCP should provide the following information:

- The organization, procedures, and responsibilities for a CCT;
- Roles and responsibilities of QA, process control, production operations, manufacturing planning, environmental compliance, personnel safety, and other contractor organizations for the CPC effort;
- A discussion of corrosion prevention techniques employed in design and how the design will meet the projected environmental spectrum;
- Specifications (process/finish specifications in system/equipment) that outline the application of coatings and other corrosion prevention compounds (if any) and that address personnel training and qualification, material inspection, surface preparation, and coating or compound application procedures;
- Participation in test planning and execution to assure proper and effective testing is accomplished at all levels of design, manufacture, and verification;
- Any test data developed, or to be developed, for coatings or other corrosion-related materials and processes;
- Identification of coating-substrate combinations for which no testing is to be performed, with an assessment of risk levels in the absence of testing; and
- Recommended specific corrosion control maintenance.

The CPCP should include any facilities that may or will be needed to support the CPC efforts on the system/equipment. As a minimum the CPCP should:

- Identify and describe the facilities that support the system/equipment CPC production and/or sustainment efforts;
- Describe how the CPT will assure adequacy and timeliness of the facilities; and
- Identify the right people and agencies that should be involved in assuring proper and timely procurement and construction of these facilities. These people and agencies should also be responsible for assuring that CPC planning and incorporation occurs on the facilities themselves as they are designed, constructed, and sustained.

The identification of these CPC-supporting facilities should be integral to the Facilities Product Support Element (PSE) and included in the Supportability Analyses accomplished with the Product Support development efforts. These facilities should be included in the Independent Logistics Assessments (ILAs) periodically mandated or required of a program, system, or equipment.

When F&I support is required and considered, at least five years should be allowed for programming of new facilities and real estate acquisition, which should also include an assessment of existing assets to determine if they meet program needs.

For F&I that is integral to the operation of the system being acquired, such as the CHEMDEMIL facilities or a corrosion control hangar, the CPCP should address these facilities and the CPT should be actively involved with the design and construction agents to ensure that appropriate CPC features are included in the constructed facility and appropriate support and lifecycle considerations are included. A proactive CPCP/CPT approach in this context will ensure system F&I longevity. The CPCP should be tailored to address specific program requirements, not simply a boilerplate combination of other documents.

A Contractor CPCP is the plan for implementing a robust and effective CPC program by the contractor. If adopted, it should be a contract deliverable and be approved by the Government. It should use the Government CPCP as a foundational document but contain more detail about the contractor's CPC planning and activities. Consider use of a tailored DI-MFFP-81403 to define the Contractor CPCP and its contents.

**Note:** DI-MFFP-81403, *Corrosion Prevention and Control Plan*, references MIL-STD-1568, which currently exists as MIL-HDBK-1568. The information in MIL-HDBK-1568 can still be used to develop the tailored DI-MFFP-81403 requiring the delivery of the Contractor CPCP. Further, MIL-HDBK-1568 is for aerospace systems. Consider this when tailoring your Contract Data Requirements List (CDRL) item.

#### **4.1.4 Corrosion Prevention Team**

The PM is encouraged to establish a body with the purpose of focusing and emphasizing CPC planning and execution. Traditionally this body is the CPT. However, if this focus and emphasis can be established using a different management structure (e.g., IPTs, WIPTs), the PM should feel free to do so. The intent is to assure focus and emphasis on this critical issue.

The PM or head of the procuring activity should identify a CPT chairperson, assign the initial membership of the CPT, and give general direction on its mission, roles, and responsibilities. Once formed, the CPT would further detail its functions.

The CPT should:

- Prescribe the membership and organization of the CPT, describe basic duties of team members, define operating procedures, and prescribe appropriate specifications and standards used in the system/equipment;
- Outline or document the RFP and contract requirements necessary to execute the CPCP;
- List applicable specifications and standards;
- Address system/equipment definition, design, engineering development, production, and sustainment phases, ensuring they are consistent with the design life and affordability of the system/equipment;
- Include the process/finish specification (materials and processes for CPC) that specify the detailed finish and coating systems to be used on the procured system/equipment; and
- Address sustainability and logistics considerations.

##### **4.1.4.1 Corrosion Prevention Team Establishment and Scope**

The roles of the CPT and requirements of when to establish a CPT vary depending on the type of program. Establishment of the initial CPT should be as early as possible but certainly as soon as a program is established.

The CPT is actively involved in the review of all design considerations, material selections, costs, and documentation, including Statements of Work (SOWs) that may affect CPC throughout the life of the system/equipment. The CPT advises the PM on corrosion-related issues, confirms the adequacy of the corrosion maintenance documentation and guidance as they are developed, and elevates unresolved issues to the Corrosion Control and Prevention Executive (CCPE) and/or Office of the Secretary of Defense OIPT for ACAT I programs. While contractors are expected to participate as part of the CPT at the appropriate time, the contractor is also encouraged to establish its own internal equivalent management structure. Historically, this equivalent management body is the CCT. Participation in the CPT or equivalent and establishment of the CCT or equivalent should be included where appropriate in the requirements language.

#### **4.1.4.2 Corrosion Prevention Team Membership**

The PM or a qualified representative of the procuring activity should assign a qualified chairperson to lead the CPT. The CPT should include representatives from appropriate DoD activities and contractor staff (when appropriate). The qualifications of the individual selected to become the CPT chairperson will change over the phases and lifecycle of the system/equipment, as will the composition of the membership.

CPT members should be designated by the PM or the CPT chairperson and include all involved Military Services.

Membership of the CPT from within the program office should be, as a minimum:

- Program/Project Management
- Systems Engineering
- Life Cycle Logistics
- Test and Evaluation
- Contracting
- Budget and Finance
- Facilities (if appropriate)

Membership from the Services and other external organizations should include but not be limited to:

- Program engineering and support;
- Individual(s) from the Service Corrosion PO, technical authority, or the equivalent;
- Corrosion expertise and subject matter experts (SMEs), which may include:
  - Individual Service laboratory material engineers;
  - Corrosion personnel from the user command;
  - Information Analysis Center personnel, such as Advanced Materials, Manufacturing, and Testing Information Analysis Center (AMMTIAC);
  - Operational Test personnel; and
  - Contractor members (once the contract is awarded).

The following are keys to success in the establishment of a CPT or any other management approach:

- **Manpower Needs:** Early on, POs/PMs should identify and secure adequate manpower to address corrosion issues. This should include internal and external manpower needed to assure proper CPC focus. The needs will change over the life of a program, both in quantity of people and their skills.
- **CPC Training Classes/Resources:** All CPT members should be encouraged to take the CPC overview course (CLM 038) and other relevant corrosion education courses available on the Defense Acquisition University (DAU) website ([www.dau.edu](http://www.dau.edu)). Additional training resources are available at [www.corrdefense.org](http://www.corrdefense.org) and [www.corrconnect.org](http://www.corrconnect.org).
- **CPT Policies, Requirements, Instructions, and Guidance:** CPT leadership should be knowledgeable of corrosion policies, requirements, instructions, and guidance.
- **User Participation:** User involvement and feedback is extremely important, and user involvement in the CPT should be solicited from the team's inception.

#### **4.1.4.3 Corrosion Prevention Team Duties**

DoD team members have several responsibilities:

- Establish and maintain a management and technical approach;
- Interface with the CCT to ensure the program goals are attained;
- Monitor all activity during design, engineering, testing, and production;
- Advise the PM or project manager on corrosion-related issues and identify risks as well as corrosion prevention opportunities;
- Attend appropriate CCT meetings;
- Advise the program on technical issues to be resolved;
- Review and resolve discrepancies submitted by the PO/PM or project manager;
- Schedule reviews as frequently as deemed necessary by the chairperson; and
- Provide an independent and objective assessment of the contractor's planning and execution of the CPC strategy.

The CPT should also advocate for money for studies or research and development (R&D) to validate the need for such changes. Programs should also make use of alternative sources of funding for R&D needs, such as the sponsoring of topics for the Small Business Innovative Research (SBIR) program, various environmental programs, such as Environmental Security Technology Certification Program (ESTCP), Strategic Environmental Research and Development Program (SERDP), Commercial Technologies for Maintenance Activities (CTMA) program, and value engineering (VE).

To evaluate the adequacy of the contractor's efforts in CPC, the PM or designated representative should conduct periodic reviews of the contractor's design where critical parts and assemblies are being fabricated, processed, assembled, and readied for shipment.

#### **4.1.5 Contractor Corrosion Team**

The contractor's team members should be authoritative representatives of the contractor's organizations. They ensure proper materials, processes, and treatments are selected and are properly applied and maintained from the initial design stage to the final hardware delivery as a minimum.

#### **4.1.5.1 Contractor Corrosion Team Membership**

The membership of the CCT should include representatives from the project design IPTs, material and process engineering, operations and manufacturing, quality control (QC), material (or subcontractor) procurement, product support, finance, T&E, and contracting. This representation is intended to be flexible, and the recommended membership may be altered. It is recommended that a CCT chairperson be selected and serve as the manager of the CCT and the contractor focal point for the program.

#### **4.1.5.2 Contractor Corrosion Team Duties**

The primary function of the CCT is to ensure adequate CPC requirements are planned and implemented for systems/equipment during all phases of the system/equipment lifecycle. CCT duties should be outlined in the CPCP, which should be included as a part of the initial RFP/contract requirements. Specific CCT responsibilities should include the following, as a minimum:

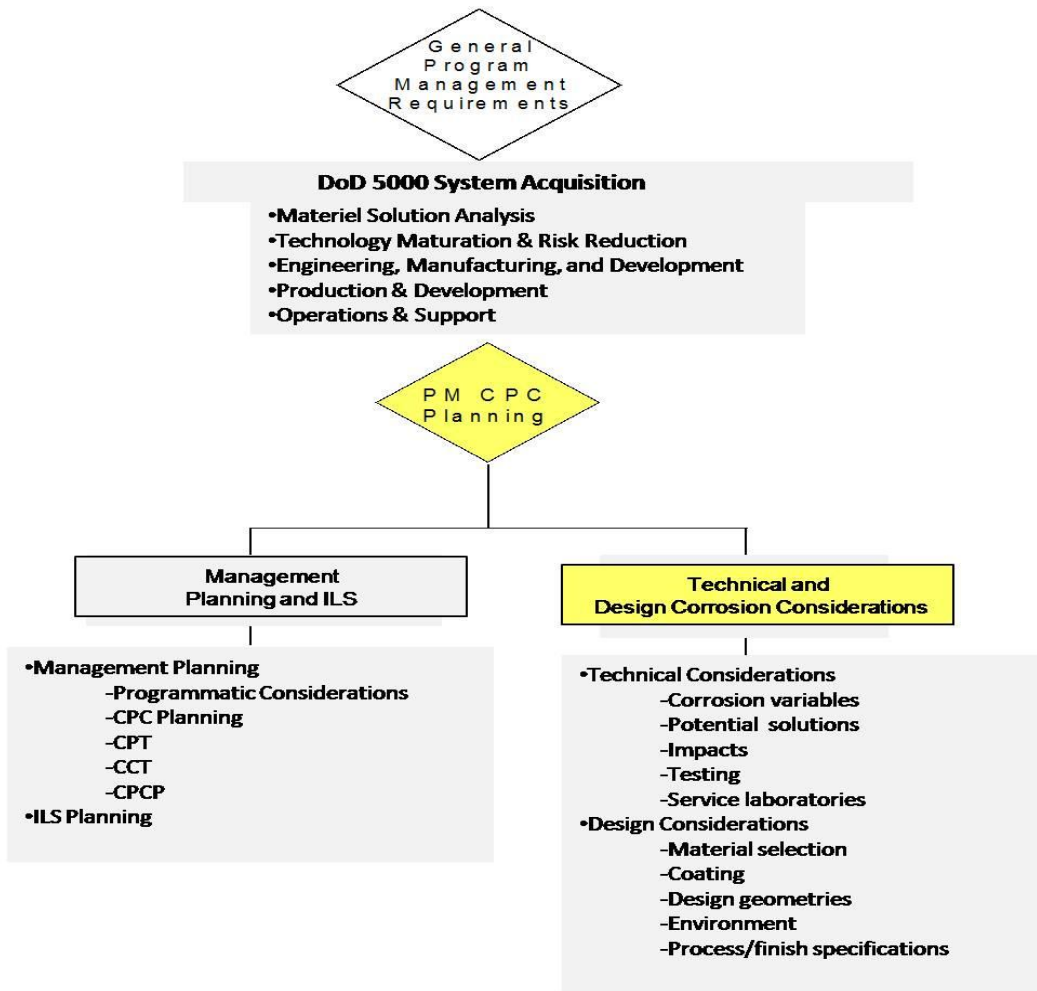
- Ensure appropriate documents outlined under discussion of CPCP are prepared and submitted in accordance with the required schedule; and
- Obtain necessary design reviews, clarifications, resolutions of any differences in technical position, and final approval of the documentation on a timely basis.

The chairperson or designee should:

- Establish periodic meetings as required to resolve problems as they occur;
- Convene other meetings if a critical or major problem arises and requires action by the team; and
- Notify all DoD and contractor members of each meeting date, the topics to be discussed, and any decisions resulting from the previous meeting;
  - Sign off on all production drawings after review of material selection, treatments, and finishes;
  - Maintain a continuous record of all action items and their resolutions; and
  - Establish principal tasks to be accomplished to implement CPC procedures in all phases of construction or in the system/equipment contractor and subcontractor manufacturing facilities.

## **4.2 Technical and Design Considerations**

There are specifications and material selection criteria that should be considered as early in the planning process as possible (and included in the CPCP). System/equipment corrosion performance is a function of material selection/design and corrosion control processes (see Figure 4).



*Figure 4: The Corrosion Planning Model—Technical and Design Considerations*

The design of DoD systems/equipment requires the proper blend of safety, affordability, and environmental needs with mission and operational requirements. DoD systems/equipment should:

- Be reliable and reduce the impact of corrosion over operations and maintenance (O&M) over the lifecycle of a system/equipment cost-effectively, and
- Minimize environmental impact due to corrosion and mitigation (i.e., hazardous materials).

Materials, manufacturing methods, and protective treatments that minimize and/or negate corrosion should be considered during the selection of suitable materials and appropriate manufacturing methods that will satisfy system/equipment requirements. The following are common categories of material degradation and are defined in Appendix V:

- General Corrosion;
- Galvanic Corrosion;

- Pitting Corrosion;
- Crevice Corrosion;
- Dealloying;
- Intergranular Corrosion;
- Stress Corrosion Cracking;
- Hydrogen Embrittlement;
- Corrosion-Fatigue;
- Flow-Assisted Corrosion;
- Fretting Corrosion; and
- Stray Current Corrosion.

The CPCP and system/equipment specifications should identify specific technical requirements related to CPC. Fundamentally, the design and design disciplines should allow for the evaluation of the following general approaches:

- Selecting the right materials and manufacturing processes;
- Applying protective coatings as necessary;
- Using proper CPC designs; and
- Physically modifying the environment to mitigate corrosion (e.g., dehumidification, sheltering).

The design should also attempt to eliminate corrosive contaminants (i.e., poultice, corrosive cleaners and fluids, salt-ridden products). If materials are to be exposed to contaminants, precautionary measures should be taken throughout the design phase to minimize deterioration of individual parts and assemblies, as well as the system/equipment as a whole. Precautionary measures are included in the technical and design considerations discussed below.

#### **4.2.1 Material Selection**

If possible, materials unsuitable to the operational environment should be avoided. Consider compatibility when using multiple materials. If dissimilar materials cannot be avoided, isolate those materials from each other. Information sources include the following:

- DoD Corrosion website (<http://www.corrdefense.org>)
- MIL-STD-889, *Dissimilar Metals*.
- MIL-HDBK-1568, *Military Handbook: Materials and Processes for Corrosion Prevention and Control in Aerospace Weapons Systems* (18 July 1996)
- *Corrosion Prevention and Control: A Program Management Guide for Selecting Materials* (<http://www.corrdefense.org>)

#### **4.2.2 Protective Coatings**

The CPT should consider protective coatings to isolate vulnerable materials from the environment. This refers to protective coatings intended to mitigate corrosion. The CPT should consider the impact of functional coatings on corrosion performance of the system/equipment. When selecting coatings, special attention should be paid to coating application processes, and the environmental impact and occupational health concerns (e.g., hexavalent chromium, isocyanate).

### **4.2.3 Design Geometries**

Avoid crevices when possible. Avoid design features that make it difficult for protective coatings to function (sharp corners, for instance), and avoid geometries that unnecessarily trap moisture (provide drainage pathways and ventilation when possible). Provide necessary access for maintenance and inspections.

### **4.2.4 Environmental Mitigation**

When it is necessary for a portion of the system/equipment to be exposed to the environment, consider a design allowing for mitigation of the environmental exposure. Dehumidification, sheltering, and wash-down can be effective means for mitigating the environment.

### **4.2.5 Process/Finish Specification**

The prime contractor should be required to prepare a process/finish specification or an equivalent document as soon after Milestone B as possible but prior to Milestone C. This specification document should identify specific organic/inorganic surface pretreatments and coatings, other CPC materials, and processes intended for use. DI-MFFP-81402, *Finish Specification Report*, can be tailored for delivery of the process/finish specification. While DI-MFFP-81402 references MIL-STD-1568 (which is currently MIL-HDBK-1568) and is intended for aerospace systems use, it may be tailored to deliver the Specification. After the specification document has been approved by the responsible DoD activity, all requirements from the specification document should be incorporated in all applicable drawings and maintenance documents.

### **4.2.6 Other Technical Considerations**

Corrosion performance is both an attribute of an entire system/equipment and the sum of the performance of components or individual items. The effects of the design, including configurations and coatings, manufacture or construction, operation, and maintenance corrosion performance specifications for complex systems/equipment should be addressed first at the component or item level. Technical considerations in the implementation of effective corrosion performance specifications include the following variables that influence corrosion:

- Environmental Variables:
  - Duration of exposure;
  - Temperature;
  - Duration of wetness and wet/dry cycles;
  - Exposure to specific corrodents; and
  - Concentration of corrodents.
- System Variables:
  - Manufacturing processes;
  - Maintenance concepts;
  - Sufficiency of maintenance;
  - Interfaces with other systems/equipment;
  - Adherence to original qualification standards and QA/QC processes;
  - Diminishing Manufacturing Sources and Material Shortages (DMSMS);
  - Operational effects (e.g., vibration, abuse, material stress, fatigue)
  - Conflicting performance parameters; and
  - Expansion of mission requirements (usage in conditions other than originally required).

#### **4.2.7 Common Methods of Corrosion Control**

The large number of variables influencing corrosion and performance can lead to an equally large number of potential solutions. Some solutions might not be compatible with the system/equipment design and operation. The design approach should be sufficiently flexible to allow the designer and manufacturer to consider the entire range of potential solutions. Other than the design considerations and the CPCP discussed above, common methods of corrosion control include:

- Organic barrier coatings
- Galvanic isolation
- Corrosion preventative compounds
- Cathodic protection
- Sacrificial coatings (e.g., galvanizing)
- Surface modification (e.g., weld overlays, electro-plating)
- Sealants (e.g., wet installed fasteners, crevice fillers, and polysulfide).

The design approach should be sufficiently flexible to allow the designer and manufacturer to consider the entire range of potential solutions.

#### **4.2.8 Assessments of Corrosion Impacts**

Accurate assessment of corrosion impacts is important because corrosion affects both function/safety and appearance of system/equipment. Quantitative assessment of its effects on system/equipment can be especially challenging. If planned for early and executed up front, outdoor testing can be done in an acceptable length of time rather than relying only on only lab testing. Outdoor testing of actual parts, buildup of structures, or even testing of full-scale articles can be achieved if planned for up front. The potential loss of function due to corrosion can often be quantified through physical measurements. These may include plating thickness loss, pit depth measurements, torque measurements, loss of strength, fatigue resistance, and conductivity measurements. Quantitative assessments can be costly and, as a result, are typically applied to critical items only. Hidden corrosion is difficult to detect and is a major problem. Degradation in appearance is typically evaluated in very subjective terms through comparison with visual standards, such as those specified in technical manuals and technical society standards. Methods and equipment for corrosion monitoring and inspection should be considered in the development of design and maintenance concepts.

#### **4.2.9 Accelerated Corrosion Tests**

Corrosion is a time-based phenomenon complicated by design characteristics, environment, and operational usage, among other factors. Accelerated testing is used to inform the risk analysis and decision making process in a timely fashion. Accelerated tests are most useful for ranking the relative performance of materials, coatings, etc., in a specific environment and application in comparison to a known system/equipment and are often found in coating qualification tests. Although accelerated testing can be informative, it must be used appropriately. Corrosion tests that most accurately resemble the intended system/equipment operating environment and exposure duration provide the most accurate and reliable results.

Increasing the test environment severity to produce results in a shorter period of time decreases accuracy and reliability. The risks of using accelerated test results are that they often do not

adequately reflect the effects of design changes, substantial material changes, and maintenance cycles. It is critical to establish appropriate pass/fail criteria when invoking these tests. Further, it is unlikely a single accelerated test will accurately reflect performance of the system/equipment when in service.

Accelerated corrosion testing can help the decision maker but needs to be used in an informed and appropriate manner. Including accelerated testing expertise in development and adoption of these test methodologies is highly encouraged.

#### **4.2.10 Access to Corrosion Expertise**

It is important that qualified corrosion expertise be involved in the selection and definition of specific materials/design and processes. These personnel should also assist in the preparation of the CPCP and provide direct support through the CPT.

Corrosion expertise is available from government, industry, and academia. There are several internal sources where you may access corrosion technical expertise. These include the service materials laboratories, materials and processes engineering organizations, [www.corrdefense.org](http://www.corrdefense.org), and employing command corrosion personnel. Another key resource is the CCPE, who can help identify appropriate sources for corrosion expertise.

#### **4.2.11 System Verification Plan in Acquisition**

The System Verification Plan should be included and define the types and levels of corrosion testing that should be incorporated in the Environmental Test and Verification Plan. Operational environmental testing should be done at the component, subsystem, and system/equipment levels, as appropriate. The plan should provide the rationale for verification of the corrosion design. In addition, the plan should reflect the environmental spectrum expected over the life of the system/equipment and the method for monitoring and tracking exposure such that environmental effects can be evaluated. Standard government or industry test methods should be used when possible. Component or subsystem testing should reflect both the severity and duration of exposure.

Success criteria should include both retention of functionality and freedom from required corrosion repair per specified performance requirements. Qualification should be based on environmental exposure testing to the system/equipment requirements. Caution should be exercised when qualification is performed by analysis or similarity and should be appropriately assessed by the CPT. CPC performance may be significantly impacted by non-similar influences, such as geometries, installed orientation, usage profiles, and environment. Corrosion criteria should be included in full-scale testing, including reliability and environmental testing.

#### **4.2.12 Quality Control and Assurance in Corrosion Prevention and Control Planning**

System/equipment corrosion performance is a function of both materials and corrosion control processes. QC and QA are critical for verifying that the system/equipment meets corrosion control requirements. This is especially important for coatings application processes. The assistance of SMEs in QA/QC is of great help to the government inspectors because of the complex nature of government QA/QC in manufacturing facilities and because few experienced with corrosion prevention aspects.

#### 4.2.13 Hexavalent Chromium Requirements

Hexavalent chromium (Cr6+) compounds are used in a number of materials and processes on DoD systems/equipment and infrastructure for their demonstrated corrosion protection properties. On 8 April 2009, the USD(AT&L) issued a memorandum recognizing the human health and environmental risks associated with the use of Cr6+ and directed all Military Departments to take action toward minimizing its use where acceptable replacements are available ([http://corrdefense.nace.org/corrdefense\\_summer\\_2009/images/memo.pdf](http://corrdefense.nace.org/corrdefense_summer_2009/images/memo.pdf)). In May 2011, Defense Federal Acquisition Regulation Supplement (DFARS) 48 Code of Federal Regulation (CFR) 223 and 252, was issued to address Cr6+ delivery through contracting practices

([http://db.materialoptions.com/ASETSDefense/SEDB/Cr\\_Alts\\_Other/ESH/DON%20HexCr%20Auth%20Process\\_Signed\\_22Dec11\\_released.pdf](http://db.materialoptions.com/ASETSDefense/SEDB/Cr_Alts_Other/ESH/DON%20HexCr%20Auth%20Process_Signed_22Dec11_released.pdf)). The use of Cr6+ may require a waiver, per DFARS.

#### 4.2.14 Commercial Off-the-Shelf Items

Although use of COTS, government off-the-shelf (GOTS), NDIs, or derivatives of these may benefit the acquisition of a system/equipment, it can complicate the CPC planning process and introduce risk to long-term sustainment. Exercising due diligence on CPC planning for these types of products is critical. Regardless of the system/equipment, CPC planning and execution principles apply.

Very often operational and use environments are considerably different from the intended environment or use of the COTS/GOTS/NDI/derivatives products. Even integrating these products into a military system/equipment can introduce corrosion risks.

While discipline needs to be applied in using Enclosures 1–5 for these types of systems/equipment, some areas deserve some additional emphasis. Regardless of the system/equipment, CPC planning and execution principles apply to all DoD program/systems/equipment. Some of those are listed below:

- Understand the difference between operational and use environments for which the items were designed, as well as the military application in which they will be used;
- Consider differences between the design life for commercial use and the intended operational life for which the item is being procured;
- Analyze effects when items are modified;
- Understand effects of interfacing items with other COTS/GOTS/NDI/derivatives and with other military systems/equipment, existing or part of the acquired system/equipment;
- Determine how to flow down corrosion/reliability requirements to these types of items;
- Analyze and understand risks involved with subsequent changes to COTS materials, designs, and data over the life of the system/equipment for which the Government has no control;
- Consider the Technical Data Rights Strategy, availability of technical data, and the cost of procuring needed data

- Reliability and maintainability data: Failure modes of parts/subsystems; service/maintenance data; field service reports; service difficulty reports; other government/commercial service reporting systems;
- Provisioning data: parts demand and why too many parts are in supply;
- Quantify reliability, lifecycle costs, and operations and support risks;
- Consider and plan additional corrosion-related testing/accelerated testing;
- Establish or adapt a maintenance concept considering the additional factors induced by use of these type items in a system/equipment, especially considering the difference in the maintenance concept for these type of items and how the military typically supports its systems/equipment;
- Consider the use of VE; and
  - Improve reliability and maintainability of parts and share savings, and
- Determine if special or additional packaging, handling, storage, or transportation will be required by virtue of adding these type items in the system/equipment.

## 5.0 Document Structure

This Guidebook provides five Enclosures to assist acquisition workforce Personnel in addressing CPC in each phase of the system life-cycle. Finally, five Appendices are provided to assist the reader in understanding these topics.

### Enclosures

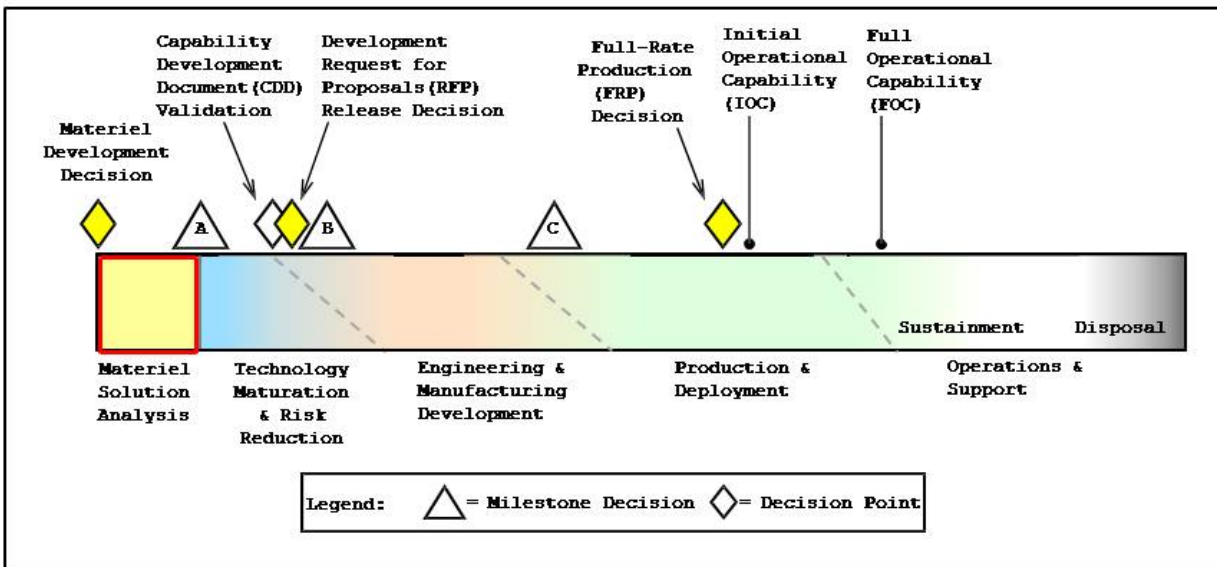
Enclosure I	Materiel Solution Analysis Phase and Pre-Milestone A Activities
Enclosure II	Technology Maturation and Risk Reduction Phase and Pre-Milestone B Activities
Enclosure III	Engineering and Manufacturing Development and Pre-Milestone C Activities
Enclosure IV	Production and Deployment Phase
Enclosure V	Operations and Sustainment Phase

### Appendices

Appendix I	References
Appendix II	Acronyms
Appendix III	Definitions
Appendix IV	CPC for MAIS Programs
Appendix V	12 Types of Corrosion

## ENCLOSURE I: MATERIEL SOLUTION ANALYSIS PHASE AND PRE-MILESTONE A

The Materiel Solution Analysis (MSA) Phase is the first opportunity for Corrosion Prevention and Control (CPC) planning to have the greatest influence on the total cost of ownership (see Figure 1). The MSA Phase is the most desirable point in the lifecycle to begin CPC planning, because this is where the user's desired capabilities are first formed. Early CPC planning supports the program/system/equipment supportability and affordability objectives by balancing technology opportunities with operational and sustainment requirements. During MSA, various CPC technologies and needs should be analyzed to assist in selection of the materiel solution and influence the Analysis of Alternatives (AoA) and Technology Development Strategy (TDS). CPC planning should be reflected in the Systems Engineering Plan (SEP), Test and Evaluation Strategy (TES), Life Cycle Sustainment Plan (LCSP), funding requirements, contracts, and Requests for Proposal (RFPs). Further, the planning and accomplishments in this Phase can support the 2366(b) certification prior to Milestone B. The Technology Development Phase RFP should include tailored requirements for CPC planning and execution. Working through suggested areas in each Phase, should help in development of the CPCP.



*Figure 1: Materiel Solution Analysis (MSA) Phase*

## 1.0 Management

Management Structure/Approach: Secure the required corrosion expertise tailored to program/system/equipment needs.

- Assure CPC planning billet(s) are identified to support the Program Management Office (PMO) (e.g., what organization/contractor should provide expertise; what seniority level is to fill the billet(s); whether the billet(s) is currently filled, or vacant); and
- Secure CPC personnel with appropriate expertise to oversee CPC planning efforts.

Early in the lifecycle, identify and assess the program/system/equipment corrosion needs to allow for the formulation of mitigation approaches and the streamlining of definition for use in the RFP processes around that critical process.

Identify and evaluate impact on corrosion following any major change or restructure to the program/system/equipment, such as significant schedule adjustment, requirements change, or change in scope of the contract.

If possible, include a materials or maintenance expert, with corrosion experience, to be part of the AoA and High-Performance Teams (HPTs).

Caution should be exercised during the AoA process when evaluating commercial off-the-shelf (COTS), government off-the-shelf (GOTS), and Government Furnished Equipment (GFE). Refer to Section 4.2.14 in this Guidebook.

Ensure that the program/system/equipment budget/funding baseline includes resources for technology and development to address corrosion. It should not be an afterthought, nor should other budget/funding be redirected for coverage.

Include Program Office corrosion personnel in key program documentation (e.g., TDS, SEP, LCSP).

For a new concept, using new materials in new ways and in new combinations, determine if there are developmental, operational, and sustainability risks that need to be included in the assessment.

Assess the CPC characteristics for critical technology elements (CTEs) associated with each proposed materiel solution, including technology maturity, integration risk, manufacturing feasibility, and technology maturation and demonstration needs.

Identify corrosion CPC technology gaps and flag for maturation in the TDS. Include estimates of corrosion-related Manpower, Personnel, and Training (MP&T) and maintenance costs based on historical experience collected from reliability and maintainability data in lifecycle cost comparisons of alternatives.

Is the system developed stand-alone, or is it part of a system of systems (SoS)? What is the relationship between this system and the other systems in relation to CPC planning, post-AoA, interfaces, requirement flow-down, and systems engineering (SE).

Refer to current policy to determine the requirements for documenting corrosion planning in key program documents (e.g., SEP, separate Corrosion Prevention and Control Plan (CPCP), LCSP, TDS, other appropriate documents). Identify:

- The approach to documenting corrosion planning;
- If the program/system has a working corrosion plan document in place (e.g., CPCP);
- The corrosion reporting methods, (e.g., Contract Data Requirements List (CDRL), PMO, Test), and what gets reported and to whom;
- The reporting method to be used for system CPC planning requirements (e.g., legacy program/system/equipment approach/part of risk management plan)
- How the program is going to collect and share information on corrosion within the DoD (e.g., lessons learned database);
- What design reports and materials reports are to be used;
- The qualification process, Qualified Products List (QPL); and
- What influences and defines contractor personnel qualifications for CPC planning and execution (e.g., MP&T requirements in RFP).

### **1.1 Current MS Execution Actions/Requirements**

Assess all potential solutions for developed and defined corrosion needs.

Develop a preliminary Acquisition Strategy (AS) that includes CPC planning, research and development (R&D), and a TDS, with corrosion prevention considered in the early stages.

Develop program/system/equipment CPC planning goals for development of critical enabling technologies that corrosion may affect.

Conduct an AoA leading to selection and approval of materials with corrosion in mind.

Understand funding requirements for CPC planning.

Ensure that the SEP supports CPC planning in the RFPs.

## **2.0 System Engineering**

### **2.1 Program Technical Requirements**

#### **Legacy Issues**

- Research corrosion effects and costs on similar legacy systems; include consulting DoD Cost of Corrosion Studies available at [www.corrdefense.org](http://www.corrdefense.org);

#### **Concept of Operations (CONOPS)**

- Describe how the operational environment is going to influence the corrosion susceptibility of the system; and
- Describe how the environmental severity may affect corrosion susceptibility on the program or cause degradation.

#### **Initial Capabilities Document (ICD)**

- Recognize CPC as a capability desired in the ICD; and

- Address CPC in the draft Capabilities Development Document (CDD) to support overall Key Performance Parameters (KPPs)/Key System Attributes (KSAs) in order to close capability gaps and achieve desired operational effectiveness.

### **Corrosion Technology Gaps**

- Identify potential R&D technology that will improve system characteristics and/or reduce life-cycle costs (LCCs), particularly considering corrosion mitigation and prevention.

### **Other Considerations:**

- Influence CPC planning requirements, RFPs, and contracts;
- Establish CPC requirements flow-down, translation to requirements, system specifications, and contract language;
- Consider CPC in SE trade studies;
- Design to minimize impact of corrosion and material deterioration on the system throughout system lifecycle and impact affordability;
- For Programmatic Environment, Safety, and Occupational Health Evaluation (PESHE)/Environmental, Safety, Occupational and Health (ESOH) responsibilities related to CPC (if applicable) identify:
  - A strategy for integrating CPC planning into ESOH considerations into the SE process;
  - A method for tracking corrosion hazards throughout the lifecycle of the program and identifying corrosion/ESOH risks and their mitigation status; and
  - CPC planning for minimization and/or safe disposal of hazardous corrosive materials associated with the program.
- Identify and manage corrosion risk areas to be addressed and minimized in the Technology Maturation and Risk Reduction Phase.

## **2.2 Engineering Resource Management**

- MP&T—Plan for appropriate manpower and skilled personnel to plan and execute CPC.
- Funding—Program and budget for CPC as early as possible.
- Corrosion R&D—Program and budget for corrosion technology gap projects:
  - Track technologies to reduce cost of corrosion, R&D products for implementation, and effects of prevention technology and processes;
  - Track effects of R&D products on corrosion mitigation and prevention; and
  - Track unique corrosion R&D topic/needs areas identified for the program.

## **2.3 Technology Activity/Products**

### **Technology R&D**

- Track technologies to reduce the cost of corrosion;
- Understand the effects of implementing R&D products on corrosion prevention;

- For Technology and Processes: track the effects of R&D products on corrosion mitigation and prevention; and
- Identify any unique corrosion R&D topic/need areas for the program.

### **Initial Capabilities Document (ICD)**

Assess and provide potential corrosion solutions needed capability in the ICD.

### **Initial Technical Review (ITR)**

From a CPC perspective, ensure that the historical and prospective drivers of system LCCs have been quantified to the maximum extent and that the range of uncertainty has been captured and reflected in the program CPC planning cost estimates.

- Assess the capability needs and materiel solution approach, and verify that requisite research, development, T&E, engineering, logistics, and the programmatic basis for the program reflect the complete spectrum of technical challenges and risks related to corrosion;
- Assure historical and prospective CPC drivers of system LCC and performance have been quantified to the maximum extent; and
- If applicable, evaluate corrosion problems and sustainment costs of the previous system considered in the development of the sustainment costs of the proposed system; identify the cost of corrosion for financial and/or availability impacts; and
- If applicable, evaluate the Program Objective Memorandum (POM) budget for development of any corrosion control technology for the system.

### **In-Service Review (ISR)**

Address CPC planning for:

- An overall System Hazard Risk Assessment;
- An operational readiness assessment in terms of system problems (hardware, software, and production discrepancies); and
- The status of current system problem (discrepancy) report inflow, resolution rate, trends, and updated metrics; these metrics may be used to prioritize budget requirements.

### **Analysis of Alternatives (AoA)**

- Describe how the program's AoA assesses CPC and planning for CTEs associated with each proposed materiel solution, including; technology maturity, integration risk, manufacturing feasibility, and technology maturation and demonstration needs;
- Use corrosion lessons learned from legacy system; consult DoD Cost of Corrosion Studies available at [www.corrdefense.org](http://www.corrdefense.org);
- Identify corrosion technology gaps (CPC planning related) and plan for programming in the TDS;

- Estimate corrosion-related maintenance costs based on historical experience collected from RAM data; and
- Identify any National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321) program compliance requirements for CPC planning and viable alternatives for environmental impacts and potential mitigation efforts.

### **Systems Engineering Plan (SEP)**

- Ensure that a CPC planning interface works with the SE working-level integration team during development of the SEP;
- Determine how the program incorporates CPC planning requirements (statutory, regulatory, derived, certification) within the methods for SE as outlined in the SEP;
- Ensure that the SEP will structure and organize the program team to satisfy corrosion requirements;
- Identify the Program's CPC planning interdependencies in terms of family of systems (FoS) for synchronizations, if applicable; and
- Identify how the SEP links SE to other corrosion management efforts (e.g., TDS/AS, test planning, sustainment planning, configuration management, risk management, and lifecycle management).

### **Alternative System Review (ASR)**

- Describe how CPC is assessed in the preliminary materiel solutions that has been developed during the MSA Phase; and
- Ensure that CPC planning is considered in the proposed materiel solution(s) (including the corresponding product support concept) that is taken forward into the Milestone decision and subsequent Technology Maturation and Risk Reduction Phase.

### **Request for Proposal (RFP)**

- Include a materials or maintenance expert, with corrosion experience, on RFP drafting and source selection teams;
- Recommend to the contracting officer how the hexavalent chromium policy should be addressed in the acquisition (i.e., ensure that the prohibition clause is not thoughtlessly included or included without explanation). Be aware that the path of least resistance might be prohibiting hexavalent chromium at this point, which might not be the best long-term decision for the system; and
- Include CPC planning and execution requirements in the Statement of Work (SOW), specifications, and CDRL.

### **Technology Maturation and Risk Reduction CDRLs**

- Identify any required CDRLs (Finish Specification and Systems CPC planning for contracting efforts);

- Include CPC Requirements for Specification;
- Include changes to specifications and standards, if invoked, define the part, section, or paragraph applicable to the procurement;
- Determine corrosion verification methods (Developmental Test/Operational Test plan and prototype testing);
- Identify CPC in trade studies;
- Ensure that the CPC strategy is complete and is reflected in the RFP;
- Ensure that the Technology Development contract contains specific requirements for the contractor regarding CPC planning;
- Include corrosion instructions and evaluation factors in Sections L and M of the RFP;
- Ensure that the Systems Engineering Management Plan (SEMP) addresses corrosion planning and corrosion's role in major subsystem design review;
- Identify the approach for risk management for CPC (i.e., part of overall risk management plan, contractor requirements);
- Identify the prioritized capability gaps based on the CPC planning risk assessment, including areas where additional risks can be accepted;
- Identify corrosion-related risks and ensure that their mitigation plans are created, funded, and tracked; and
- Identify the prioritized capability gaps based on the CPC planning risk assessment, including areas where additional risks can be accepted.

## **2.4 Current Milestone Execution Actions/Requirements**

- Include CPC planning and execution in the SEP.

## **2.5 Planning Actions/Requirements for Next Milestone**

Understand funding requirements for CPC planning;

- Plan for ITR and corrosion requirements;
- Identify technical data requirements in the Technical Data Rights Strategy (TDRS); and,
- Determine if corrosion will affect the AS.

## **3.0 Life Cycle Logistics**

### **Life Cycle Support Plan (LCSP) (Initial):**

In the development of the LCSP, CPC requirements, resource management, activities and products should be identified for sustainment. For instance:

- Identify basic CPC planning, supportability and sustainment options based on Warfighter requirements and operational concept;
- Identify potential support and maintenance challenges due to anticipated corrosion in current technology or operational environment identified;

- Evaluate potential product support and maintenance concept alternatives and identify notional concept as part of the AoA to include CPC planning;
- Identify user needs and CPC planning constraints affecting sustainment;
- Identify basic product support, sustainment, and required supportability capabilities and document in programmatic documentation including, but not limited to CPC planning, AoA, AS, ICD, and Test and Evaluation Strategy (TES);
- Use LCC estimates to assess affordability including CPC planning;
- Use Preliminary Support Planning, Supportability Analysis, and RAM analysis to identify required developmental efforts for corrosion issues;
- Ensure the TES addresses how required enabling technology and KPP/KSAs will be verified in relation to CPC planning;
- Define the notional product support, sustainment concepts and CPC needed to determine the sustainment requirements for optimizing readiness outcomes and minimal LCCs;
- Evaluate the impact of corrosion in the physical and operational sustainment environment of the proposed system when developing the CPCP;
- Develop the preliminary MP&T requirements in both quantity and skill levels, including the use of contractor support, needed for CPC planning efforts;
- Evaluate corrosion performance histories of prior programs/systems/equipment or programs/systems/equipment of similar capability when developing the operating and support reliability objectives and their corresponding benefits and resource requirements;
- Ensure that CPC is a factor when developing Rough Order of Magnitude (ROM) LCC estimates;
- Assess CPC when conducting the supportability analysis for defining the product support package;
- Identify how CPC will affect the sustainment performance requirements (e.g., availability, reliability, maintainability) that are integrated into the design process;
- Develop the AoA using CPC as one of the factors;
- Consider the effect of corrosion on system design and viable product support strategies when conducting market analysis for system and product support capabilities (public and private). The analysis should include:
  - Elements of CPC currently provided for legacy system to be replaced; consider consulting the DoD Cost of Corrosion Studies available at [www.corrdefense.org](http://www.corrdefense.org);
  - Current measures used to evaluate CPC effectiveness;
  - All existing corrosion data across the product support elements; and
  - Assessment of existing CPC technologies and associated support that affect the new system under development.
- Identify initial corrosion related risks and initiate risk mitigation planning;
- Determine the appropriate CPC planning considerations and test points in the TES; and

- Identify, as soon as possible, F&I requirements in support of the CPC program (involve F&I agencies and personnel as early as possible).

### **3.1 Current Milestone Execution Actions/Requirements**

- Develop initial support and maintenance concepts (LCSP) that include CPC.

### **4.0 Test & Evaluation**

- Highlight corrosion risks that will need mitigation verification in T&E planning efforts;
- Ensure that corrosion is included in any discussion of T&E verification of reliability and maintainability;
- Identify the assets (e.g., test articles, test facilities, MP&T, funding) necessary to verify CPC performance; and
- Assess legacy systems test programs to determine if corrosion-related testing could be improved.

### **5.0 Contracting**

In the scope of the acquisition CPC planning objectives, specific personnel such as the contracting officer, subject matter experts (SMEs), engineers, and cost analysts should be assigned to the team.

#### **Requirements Definition**

- Ensure SOW, Statement of Objectives (SOO), Performance Work Statement (PWS), and Performance/System Specifications are included in an RFP/contract language;
- Ensure CPC planning specifications and standards, if invoked, define the part, section, or paragraph applicable to the procurement;
- Ensure intellectual property/data rights are properly included for CPC planning supply support technical requirements in contractual documentation;
- Ensure that ICD considerations translate into appropriate contract language and support source selection evaluation; and
- Require prospective contractors to address past performance related to CPC qualifications and credentials in their responses.

#### **Regulatory Requirements**

- Identify regulations and any applicable legislative requirements the prospective contractor should or will need to follow in relation to CPC planning of particular importance to a planned procurement (i.e., requirement for state environmental impact study); and
- Ensure Defense Federal Acquisition Regulation Supplement (DFARS) 48 CFR 223.73 is included in order to mitigate risks of hexavalent chromium.

#### **Contract Data Requirements List (CDRL)**

- List deliverables, performance standards, timelines, etc.;
- Include a CDRL for facility and infrastructure requirements for the program/system/equipment, if necessary;
- Provide contracting officer applicable Data Item Deliverables (DIDs) DD Form 1423, for inclusion, such as:
  - DI-MFFP-81402—*Finish Specification Report*
  - DI-MFFP-81403—*Corrosion Prevention and Control Plan*
- Meeting minutes, such as Corrosion Prevention Action Team meetings; and
- Ensure DD Form 1423, Block 8, denotes requirement for government approval of deliverables where applicable; and consider adding AT&L/Director, Corrosion Policy and Oversight, and the Corrosion Control and Prevention Executive to Block 14.

#### **Source Selection Planning:**

- Ensure the inclusion of specific measureable CPC planning criteria to be used in evaluating proposals;
- Include CPC planning performance specifications with the contractual documentation to award the initial contract and to procure items;
- Consider use of Requests for Information (RFI) in conducting market research where new technologies and innovative processes are being sought;
- Develop criteria for validating proposed CPC planning and delivery as envisioned and developed by the contractor
  - Clarify the necessary qualifications of personnel (e.g., SMEs, engineering, and logistics) the program will need to acquire to ensure quality control is in place for CPC planning;
  - Establish performance review criteria (e.g., Contractor Performance Assessment Review (CPAR), references); and
- Understand expectation of bidders in the development, implementation, and management of CPC planning.

### **6.0 Cost Estimating and Budget**

The budget should provide the level of resources required to develop and procure the program system/equipment CPC planning needs.

#### **System Requirements**

- Identify CPC planning cost and funding/budget status to include appropriation, budget activity, program element, and the program/system/equipment name;
- Identify any cost/funding shortfalls for CPC planning; and
- Ensure support for MP&T, technical manuals and maintenance concepts (cost incurred).

#### **Contractor Support**

- Identify contractor support cost/funding and any known shortfalls that may affect CPC planning.

#### **Legacy System Costs**

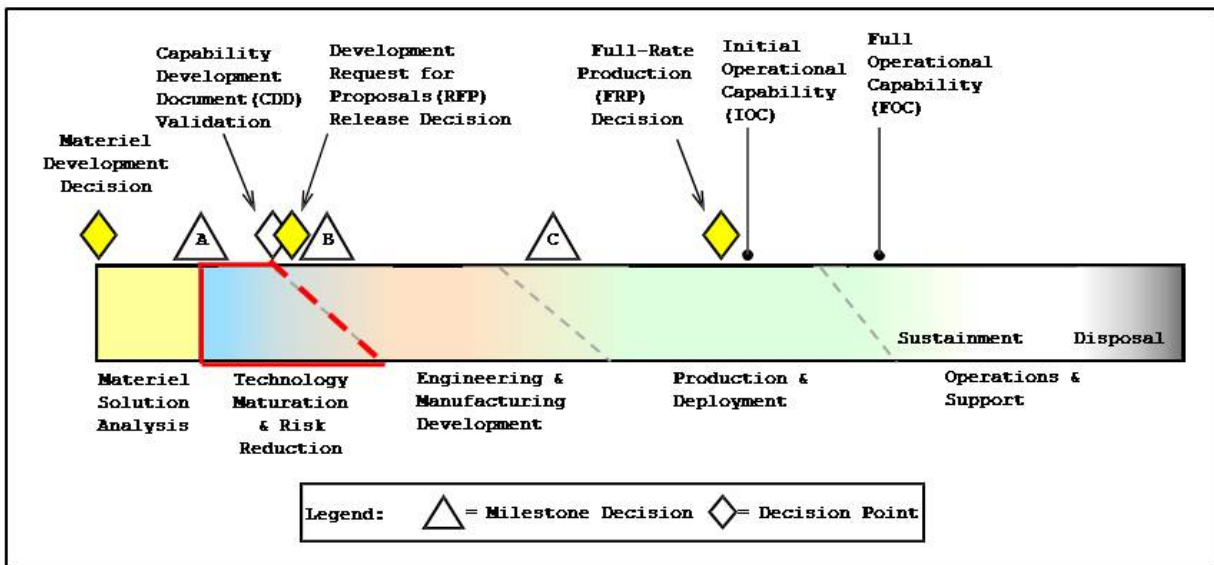
- Interface with OSD Cost Assessment and Program Evaluation (CAPE) or other appropriate cost estimating offices to ensure that lifecycle corrosion costs are included in the supportability cost models used to evaluate the cost feasibility of alternatives;
- Estimate CPC planning-related maintenance costs based on historical experience collected from RAM data; and
- Consult DoD Cost of Corrosion Studies available at [www.corrdefense.org](http://www.corrdefense.org).

## ENCLOSURE II: TECHNOLOGY MATURATION AND RISK REDUCTION PHASE AND PRE-MILESTONE B

The Technology Maturation and Risk Reduction (TMRR) Phase (Figure 1) develops and demonstrates prototype designs to reduce technical risk, validate designs, validate cost estimates, evaluate manufacturing processes, and refine requirements. Based on refined requirements and demonstrated prototype designs, integrated systems design of the end-item system can be initiated. In addition, the TMRR Phase efforts ensure the level of expertise required to operate and maintain the product is consistent with the force structure. Also, the planning and accomplishments in this phase provide the foundation for the 2366(b) certification prior to Milestone B.

**Note:** Please review previous phases for more detailed information if entering at other than Pre-Milestone A.

**Note:** Working through suggested areas in each phase should help in development of the Corrosion Prevention and Control Plan (CPCP).



*Figure 1: Technology Maturation and Risk Reduction Phase*

## 1.0 Management

Management Structure/Approach: Secure the required corrosion expertise tailored to program/system/equipment needs:

- Assure Corrosion Prevention and Control (CPC) planning billet(s) are identified to support the Program Management Office (PMO) (e.g., what organization/contractor should provide expertise; what seniority level is to fill the billet(s); whether the billet(s) is currently filled, or vacant); and
- Secure CPC personnel with appropriate expertise to oversee CPC planning efforts; and
- Identify funding requirements to ensure that CPC expertise can be assigned to the program/system/equipment team.

Identify and assess the program/system/equipment corrosion needs that will allow for the formulation of mitigation approaches and the streamlining of definition for use in the Request for Proposal (RFP) processes around that critical process. Assure CPC management planning and execution are integrated into cost, schedule, and performance metrics.

Identify and evaluate impact on corrosion following any major change or restructure to a program/system/equipment, such as significant schedule adjustment, requirements change, or change in scope of the contract.

Identify resource limitations (e.g., funding, personnel and facilities) that pose a risk to CPC planning and execution/PMO success. Ensure budget/funding for CPC functions are identified and sufficient.

If the program/system/equipment is part of a larger system of systems (SoS), understand the relationship between this program/system/equipment and the other programs/systems/equipment in relation to CPC planning (e.g., interfaces, requirements flow-down).

Refer to current policy to determine the requirements for documenting corrosion planning in key program documents (e.g., Systems Engineering Plan (SEP), separate Corrosion Prevention and Control Plan (CPCP), Life Cycle Sustainment Plan (LCSP), Technical Data Strategy (TDS), other appropriate documents). Identify:

- The approach to documenting corrosion planning;
- If the program/system/equipment has a working corrosion plan document in place (e.g., CPCP);
- The corrosion reporting methods (e.g., Contract Data Requirements List (CDRL), PMO, Test) and what gets reported and to who;
- The reporting method to be used for system CPC planning requirements (e.g., legacy program/system/equipment approach is part of a Risk Management Plan);
- How the program is going to collect and share information on corrosion within the DoD (e.g., lessons learned database);
- What design reports and materials reports are to be used;
- The qualification process, Qualified Products List (QPL); and

- What influences and defines the contractor personnel qualifications for CPC planning and execution (e.g., Manpower, Personnel, and Training requirements in the RFP).

Provide for the reporting and collection of corrosion data (e.g., CDRL, technology development reports, technology readiness, failures, risk, qualification/QPL, design, Preliminary Design Review (PDR) results).

If applicable, assign responsibility for development of the CPCP and develop management method, such as Corrosion Prevention Team (CPT) or Contractor Corrosion Team (CCT).

### **1.1 Current Milestone Execution Actions/Requirements**

Technology development is an iterative process of maturing technologies and refining user performance parameters to accommodate those technologies that are not sufficiently mature. The Initial Capabilities Document (ICD), TDS, draft Capabilities Development Document (CDD), and draft System Requirements Document (SRD) guide the efforts of this phase, leading to the approved CDD.

The TMRR Phase and CPC planning may have an impact in:

- Risk assessment;
- Program Protection Plan (PPP);
- Inputs to the Integrated Baseline Review (IBR);
- System Threat Assessment Report (STAR);
- Acquisition Strategy (AS);
- Affordability Assessment;
- Cost and Manpower Estimates; and
- System Safety.

### **1.2 Planning Actions/Requirements for Next Milestone**

Technical Reviews with CPC planning impacts during the TMRR Phase:

- IBR

## **2.0 System Engineering**

### **2.1 Program Technical Requirements**

SE Execution of Current Technology Maturation and Risk Reduction Phase

- Determine if CPC requirements can be derived from ICD and/or draft CDD;
- Establish CPC requirements, translation and flow-down to requirements, system specifications, and contract language;
- Address corrosion at technical reviews, assessments, and events;
- Analyze systems engineering (SE)/CPC planning tradeoff to show how cost varies as the major design parameters and time to complete are traded off against one another;
- Design to minimize impact of corrosion and material deterioration on system throughout program/system/equipment lifecycle that impacts affordability;

- Monitor corrosion reporting, and corrosion risks and mitigation; integrate as appropriate in SE risk management plan;
- Identify and mitigate Programmatic Environment, Safety, and Occupational Health Evaluation (PESHE)/Environmental, Safety, and Occupational Health (ESOH) risks related to CPC;
- Integrate SE functions with logistics activities and requirements, such as Integrated Logistic Assessment (ILA), Product Support (PS) Business Case Analysis (BCA), product support integration and planning;
- Establish corrosion performance verification methods, such as Test and Evaluation Master Plan (TEMP), test result reviews, and system specifications;
- Update SE approach as a result of changes or updates to Analysis of Alternatives (AoA) recommended solutions;
- Describe CPC planning requirements that have been identified for incorporation in the LCSP, TEMP, Configuration Management Plan (CMP), TDS, CPCP, etc.;
- Refine quantifiable CPC performance requirements along with suitable evaluation methods and reflect them in the system specification, SEP, and TEMP; and
- Identify update to SEP input after contract award to document the major CPC events, revisions, slips in the schedule, technology immaturity, etc., that have occurred.

## **2.2 Engineering Resource Management**

Establish and maintain resources for management of the CPC planning and execution functions (e.g., CPT, Integrated Product Teams, working groups, subject matter experts).

### **Systems Engineering Plan**

- Ensure a link of SE to corrosion management efforts (e.g., TDS/AS, test planning, sustainment planning, configuration management, risk management, lifecycle management);
- Ensure CPC planning interfaces with the SE Working-level Integrated Product Team (WIPT) during development of the SEP;
- Work with SE management to support CPC planning requirements (e.g., statutory, regulatory, derived, certification);
- Ensure manning, personnel, and organization of the program/system/equipment team is adequate to satisfy CPC requirements;
- Review and evaluate CPC planning interdependencies in terms of systems of systems, if applicable;
- Review and evaluate CPC planning human systems interface/integration initiatives required to optimize total system performance and minimize total ownership cost (TOC) of the program/system/equipment; and
- Ensure budget/funding for CPC functions are identified and sufficient.

### **Corrosion Research and Development (R&D)**

- Review and evaluate unique corrosion R&D topic/need areas identified for the program/system/equipment;
- Review and evaluate the effects of R&D products on corrosion mitigation and prevention; and
- Review and evaluate of technologies to reduce cost of corrosion, R&D products for implementation, and effects of prevention technology and processes.

## **2.3 Technology Activity/Products**

### **System Requirements Review (SRR)**

- Review and evaluate of CPC requirements support development of the program/system/equipment, which is responsive to the material solution decision.

### **System Functional Review (SFR)**

- Review and evaluate the linkage between CPC requirements and the functions that might affect program/system/equipment operation/availability and/or increase/decrease the program/system/equipment TOC.

### **Engineering and Manufacturing Development (EMD) Review**

- Review and evaluate all appropriate programmatic documents including corrosion planning and execution.

### **Preliminary Design Review (Pre-Milestone B) (for each prototype)**

- Evaluate CPC characteristics;
- Develop or update the CPCP and/or Contractor CPCP;
- Demonstrate incorporation of legacy program/system/equipment lessons learned in the allocated baseline of the program/system/equipment;
- Address CPC Hazardous Materials (HazMat) in the PESHE and other appropriate documentation;
- Demonstrate that user requirements relevant to CPC have been allocated (e.g., longevity, lifecycle cost, maintainability, availability) and verification methods are established;
- Identify CPC risks and mitigation approaches; and
- Outline CPC considerations in manufacturing (e.g., coatings procedures, rework methods, personnel certifications, quality control (QC) processes).

### **EMD RFP (CPC strategy complete and reflected in RFP)**

- CPC planning and execution requirements are in procurement documentation, such as Statement of Work (SOW), specifications, Data Item Descriptions (DIDs), and CDRL);
- Consider CPC in trade studies;
- Ensure that CPC is integrated within risk management approach (part of program/system/equipment RMP)

- Identify if/when CPC risks may impact cost, schedule, and performance;
- Ensure that EMD CDRLs (e.g., System Engineering Management Plan, System Specification, finish specification, Contractor CPCP, design reports, TEMP, TDRS, test reports, HazMat requirements) address CPC planning and execution and include delivery frequency and approval authority information;
- Determine which commercial or military specifications and standards will be used to implement the CPC requirements;
- Review and evaluate design considerations (e.g., geometries, material selection, coatings, QC);
- Determine and document (i.e., TEMP) corrosion verification methods (e.g., contractor testing, environmental/climactic testing, Developmental Test/Operational Test (DT/OT) plan, prototype testing); and
- Include corrosion instructions and evaluation factors in Sections L and M of the RFP.

## **2.4 Current Milestone Execution Actions/Requirements**

CPC planning may have an impact on the:

- SEP
- Technology Readiness Assessment (TRA);
- System Support and Maintenance Objectives and Requirements;
- CDD;
- SRR;
- SFR;
- PDR; and
- PESHE.

## **2.5 Planning Actions/Requirements for Next Milestone**

Planning Requirements, RFPs, and Contracts:

- Develop the CPCP;
- Describe how the operational environment and Concept of Operations (CONOPS) influence the corrosion susceptibility of the system;
- Establish CPC requirements flow-down, translation to requirements, system specifications, and contract language;
- Identify the effect of environmental severity on the program/system/equipment relative to corrosion, degradation, or warranty issues and ensure that it is addressed in the LCSP;
- Analyze SE/CPC planning tradeoff to show how cost may vary as the major design parameters and time to complete are traded off against one another;
- Design to minimize impact of corrosion and material deterioration on the program/system/equipment throughout the lifecycle that impacts affordability;

- Integrate CPC planning into SE processes to include method for tracking hazards and corrosion risks and develop mitigation plans throughout the lifecycle of the program/system/equipment;
- Integrate SE functions with logistics activities and requirements (e.g., LCSP, ILA, PS BCA, product support integration and planning);
- Verify SE requirements with test activities and functions (e.g., TEMP, test result reviews);
- Identify PESHE/ESOH responsibilities, requirements, hazard reporting, and mitigation related to CPC;
- Ensure mitigation of corrosion risks are that are identified TMRR Phase, continue into the EMD Phase;
- Relate CPC planning and requirements to impacts of corrosion (cost and performance) in relevant Key Performance Parameters (KPPs), Key System Attributes (KSAs), and other metrics or requirements;
- Review historical CPC lifecycle cost and performance drivers and develop potential improvements/mitigation methods;
- Describe CPC integration into the final design tradeoffs to assess cost and or maintenance planning impacts on solutions; and
- Consider effects of CPC processes and materials on environmental concerns (e.g., PESHE, use of HAZMATs such as hexavalent chromium).

#### **Legacy Issues:**

- Describe the use of Reliability, Availability, and Maintainability (RAM) data and cost, lessons learned from legacy programs/systems/equipment; and
- Consult the DoD Cost of Corrosion Studies at [www.corrdefense.org](http://www.corrdefense.org).

#### **CDD/CONOPS:**

- Describe the program/system/equipment approach for influencing CPC planning requirements in CDD and CONOPS, if applicable.

### **3.0 Life Cycle Logistics**

Management of CPC-related sustainment related risk should focus on the implementation of the product support package. Following the developed approach for fielding the product support package, describe who, what, when, where, and the associated funding/budgets. In addition to refining and expanding on the CPC sustainment management approach, schedule, costs, and performance aspects:

- Finalize the sustainment metrics, determining how CPC methods/processes can improve sustainment support and providing lessons learned;

- Identify how CPC will affect the sustainment performance requirements (e.g., RAM) that are integrated into the design process and included in the CDD and is the basis of design requirements for subsequent phases;
- Translate program/system/equipment design requirements into facilities and infrastructure (F&I) support planning criteria that needs to be included in the CPC requirements development;
- Document the integration of sustainment requirements, including appropriate CPC techniques, into the program/system/equipment design;
- Ensure that the CPC is reviewed and evaluated when expanding/updating the sustainment strategy and maintenance concept;
- Develop an execution plan that can deliver the product support package, which includes the integration of CPC methodologies;
- Ensure the budget/funding for CPC functions is identified and sufficient;
- Refine lifecycle cost estimates for CPC;
- Collect/update corrosion related maintenance costs that have been estimated based on historical experience collected from RAM data;
- Update MP&T requirements to include the use of contractor support needed for CPC planning efforts;
- Update CPC planning related to performance and acceptance criteria to be demonstrated during planned testing and through modeling and simulation;
- Review/update CPC requirements if changes are made to the program/system/equipment AoA;
- Define the extent and scope of opportunities, the effect of corrosion on program/system design, and viable product support strategies when conducting market analysis for program/system/equipment and product support capabilities (public and private). Analysis should include:
  - Elements of CPC currently provided (for legacy system to be replaced); also consult the DoD Cost of Corrosion Studies at [www.corrdefense.org](http://www.corrdefense.org);
  - Current measures used to evaluate CPC effectiveness;
  - All existing corrosion data across the product support elements; and
  - Assessment of existing CPC technologies and associated support that affect the new program/system under development;
- Identify corrosion related risk and risk mitigation planning;
- Apply CPC planning for Advanced Concept Technology Demonstrations (ACTDs), Advanced Technology Demonstrations (ATDs) and other technology-oriented demonstrations, where applicable;
- Determine the appropriate CPC planning considerations and test points in the TEMP;
- Identify Product Support Strategy details for CPC (including the depot maintenance requirements and the implications of core requirements) and what is expected from each of the stakeholders;

- Identify performance verification of CPC methods used in production, fielding, and operations. This should include the design characteristics in the contract, how they will be demonstrated, and their performance to date;
- In CPC outcome-based contracts, include the level that will be covered by performance-based incentives tied to metrics;
- Assess results to date and the product support risks;
- Ensure major actions/events for the product and CPC support package elements fit with the overall program/system/equipment master schedule, including the interfaces and dependences between the elements; and
- Identify F&I requirements in support of the CPC program as early as possible, and involve F&I agencies and personnel.

### **Independent Logistics Assessment (ILA) (if performed)**

- Ensure projected maintenance intervals and levels are consistent with the assumptions made in the effectiveness of the corrosion control technology lifetimes;
- Conduct program/system/equipment supporting facility requirements reviews including relevant aspects of corrosion in the areas of design and materials selection, cathodic protection, industrial water treatment, and protective coatings specific to possible basing areas and program/system/equipment support interfaces;
- Begin the process of anticipating, envisioning, and conceiving program/system/equipment supporting facility requirements and design out legacy issues. Consider plans to locate the program/system/equipment at an existing home base. Review existing F&I for possible use and/or expansion to accommodate the new loading;
- Include choices for supporting F&I (i.e., aircraft size vs. hangar type) in the AoA considerations, since this will affect CPC requirements and complexity;
- Identify program/system/equipment supporting facility solutions that could substantially assist with meeting initial capability, such as increased port or airfield capacities or new or expanded training facilities, all of which could affect CPC planning and have lifecycle impact;
- Ensure awareness that it takes approximately five years to acquire new or substantially modified program/system/equipment supporting F&I after detailed requirements are known;
- Establish a CCT and funding for each prime contractor to participate with a government team and plan work as described in the draft system/equipment CPCP. This is to manage/flow-down of corrosion requirements to subcontractors following a process defined in the draft program or prime CPCP. Provide these details to the ILA/ILS team for consideration in conducting program/system/equipment supporting facility requirement planning;
- Identify program/system/equipment supporting F&I and ranges in TDS, including Research, Development, Testing & Evaluation (RDT&E) requirements with associated CPC impacts and gaps:

- CPC requirements for program/system/equipment supporting F&I should be addressed/determined when conducting the ILA/ILS in support of the program/system/equipment requirements;
- During the Facility Requirements Reviews, include the relevant aspects of CPC in the areas of design and materials selection, cathodic protection, industrial water treatment, and protective coatings specific to possible basing areas and program/system/equipment support and interfaces;
- Ensure CPC requirements are budgeted for and included in the ILA/ILS requirements;
- Ensure the F&I plan includes CPC requirements for the program/system/equipment; and
- Address F&I corrosion issues in the Risk Management Plan.

## **LCSP**

- Ensure that initial program/system/equipment supporting facilities and ranges capabilities have been analyzed, initial supportability objectives/requirements are identified, and initial RAM strategy has been formulated and integrated with the SE process via the SEP and LCSP and includes CPC planning;
- Incorporate CPC planning and design features into the system performance specifications to achieve the product support strategy, including diagnostics and prognostics;
- Ensure that the TEMP addresses when and how required sustainment-related design features and KPP/KSAs will be verified in CPC;
- Ensure the LCSP is written and approved, documenting the product support sustainment strategy with CPC planning;
- Identify logistics corrosion risks and mitigation strategies and document them in the LCSP; and
- Insert preliminary CPC planning in the support strategy, leveraging a best-value mix of organic and contractor support and associated logistics processes, products, and deliverables and document them in the LCSP.

## **4.0 Test & Evaluation**

- Assess past test methods and results to identify best practices and testing improvements for CPC, and reflect these in the RFP, SEP, CPCP, LCSP, and TEMP, at a minimum;
- Review prototype testing for CPC results and improvements needed during EMD, and reflect these in the RFP, SEP, CPCP, LCSP, and TEMP; and
- Identify TE assets (e.g., labs, fixtures, ranges, system articles) to accomplish needed verification and testing and include these in the TEMP, CPCP, AS, funding projections, etc.

## **5.0 Contracting**

Ensure appropriate personnel are consulted for CPC contract requirements (e.g., logistician, engineers, cost analysts, T&E).

Provide needed support to program/system/equipment development organizations or RFP development team (e.g., PM, SE, Logistics, T&E) during TMRR Phase contract(s) execution and amendment.

### **EMD RFP and SOW:**

- Establish CCT;
- Identify CPT support;
- Define flow-down of CPC requirements, processes and procedures to subcontractors and vendors;
- Define Life Cycle Logistics elements pertaining to CPC; and
- Reflect CPC in total ownership cost estimates.

### **System Specification:**

- Define performance measures necessary for CPC execution;
- Verify CPC performance; and
- Identify commercial/military specifications and standards applicable for sound CPC implementation, including appropriate tailoring.

### **FAR/DFARS requirements should request the contractor to:**

- Identify which regulations and legislative requirements contractors must follow in relation to CPC planning; and
- Mitigate risks of hexavalent chromium—DFARS 48 CFR 223.73.

### **CDRL (e.g., content, frequency, approval level):**

- CCT Charter;
- Data Item Descriptions (DIDs) to be considered (Government approved);
  - DI-MFFP-81402—*Finish Specification Report*;
  - DI-MFFP-81403—*Corrosion Prevention and Control Plan*;
- CPT and other meeting minutes;
- Technical Data delivery and data rights; and
- Be sure DD Form 1423, Block 8, denotes requirement for government approval of deliverables where applicable; and consider adding AT&L/Director, Corrosion Policy and Oversight, and the Corrosion Control and Prevention Executive to Block 14.

### **Section L (Instructions to Offerors):**

- Deliver a Contractor CPCP with the proposal to assess contractor(s) approach to CPC planning, implementation, testing, and management;

- Provide CPC implementation details (funding required, inclusion in Work Breakdown Structure (WBS) and Integrated Master Plan (IMP), etc.);
- Require the contractor to address the CPC planning past performance, qualifications, and training; and
- Require the contractor to address impact of CPC implementation and sustainment TOC.

#### **Section M (Evaluation Factors):**

- Include evaluation criteria for a Contractor CPCP sufficiency and compliance;
- Assess adequacy of IMP, WBS, and funding to ensure effective CPC implementation during contract performance;
- Evaluate CPC effects on TOC; and
- Ensure corrosion-related PDR exit criteria are satisfied.

#### **6.0 Cost Estimating and Budget**

- Ensure CPC planning is reflected in cost estimates;
- Ensure past CPC real cost influences cost estimates; use Cost of Corrosion studies;
- Assist in evaluating TOC estimates provided in proposals to be sure CPC efforts are included and sufficient;
- Evaluate BCA/trade studies sufficiency and accuracy; and
- Interface with OSD Cost Assessment and Program Evaluation (CAPE) or other appropriate cost-estimating offices to ensure that lifecycle corrosion costs are included in the supportability cost models used to evaluate the cost feasibility of alternatives.

#### **Budgeting Requirements**

- Ensure program/system/equipment budget includes sufficient coverage for CPC implementation;
- Identify funding shortfalls for CPC implementation;
- Ensure IMP and WBS reflect CPC efforts and these efforts are reflected in Earned Value Management System (EVMS); and
- Monitor performance of CPR data for CPC efforts.

### ENCLOSURE III: ENGINEERING AND MANUFACTURING DEVELOPMENT PHASE AND PRE-MILESTONE C

The Engineering and Manufacturing Development (EMD) Phase (Figure 1) is where a program/system is developed and designed before going into production. The EMD Phase starts after a successful Milestone B review and is considered the formal start of any program/system. The goal of this phase is to complete the development of a system or increment of capability, complete full system integration, develop affordable and executable manufacturing processes, complete system fabrication, and test and evaluate the program/system before proceeding into the Production and Deployment (P&D) Phase.

**Note:** Please review previous phases for more detailed information if entering at other than Pre-Milestone B.

**Note:** If you work through suggested areas in each phase, it should help in development of the Corrosion Prevention and Control Plan (CPCP).

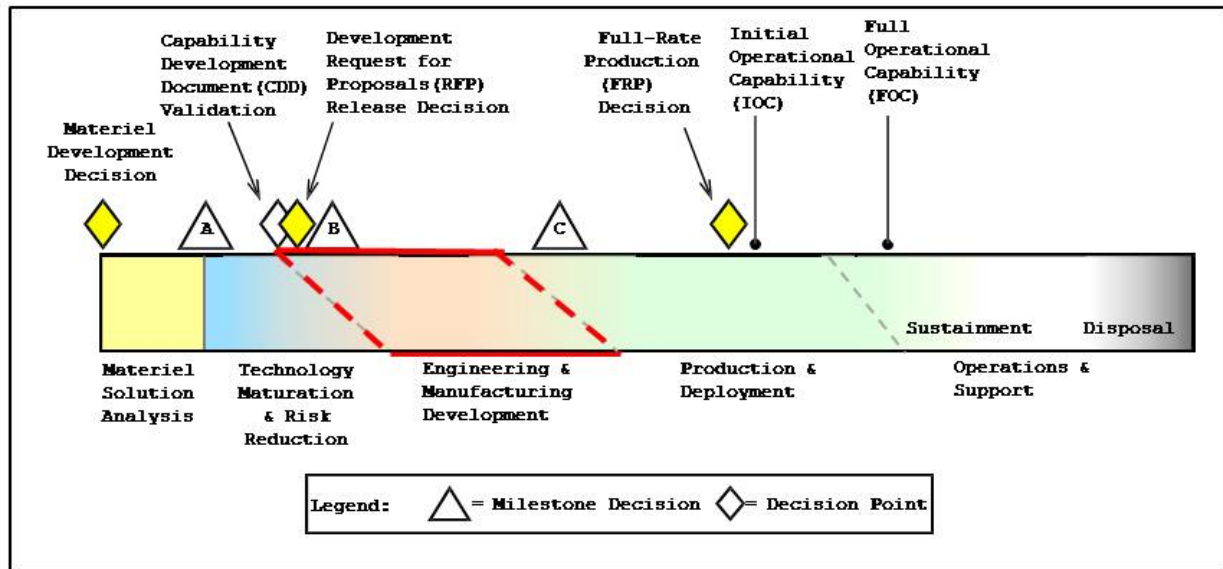


Figure 1: Engineering and Manufacturing Development (EMD) Phase

## **1.0 Management**

Management Structure/Approach: Secure the required corrosion expertise tailored to system/program needs:

- Ensure Corrosion Prevention and Control (CPC) planning billet(s) are identified to support the Program Management Office (PMO) (i.e., what organization/contractor should provide expertise; what seniority level is needed to fill the billet(s); whether the billet(s) are currently filled or vacant);
- Secure CPC personnel with appropriate expertise to oversee CPC planning efforts; and
- Identify funding requirements to ensure that CPC expertise can be assigned to the program/system/equipment team.

Early in the lifecycle, identify and assess the program/systems/equipment corrosion needs that allow for the formulation of corrosion mitigation approaches and the streamlining of both the system definition and the Request for Proposal (RFP) processes around that critical process.

CPC identification should be done following any major system change or restructure, such as significant schedule adjustment, requirements change, or scope change to the contract.

Establish and confirm that CPC expertise is in place. Assign expertise/subject matter experts (SMEs) and secure required skill set. Tailor to program needs, including:

- Identify expertise/SMEs that will oversee the program/system/equipment CPC planning efforts (e.g., systems engineer);
- Identify resource limitations that pose a risk to CPC planning and execution;
- Identify interfaces with other programs/systems/equipment (if any) and potential corrosion issues to be overcome;
- Document corrosion planning in Systems Engineering Plan (SEP), Acquisition Strategy (AS), Life Cycle Sustainment Plan (LCSP), or other appropriate documents;
- Establish corrosion reporting methods (e.g., part of Risk Management Plan (RMP), Contract Data Requirements List (CDRL), PMO, and Test).
- Establish how the program is going to collect and share information on CPC within the Department of Defense (DoD).
- Identify how deficiency reports and quality reports are to be used;
- Use lessons learned;
- Establish how the program will track product qualification;
- Establish contractor personnel qualifications, as appropriate; and
- Establish government/contractor CPC planning and execution of minutes and decision reports.

## **1.1 Current Milestone Execution Actions/Requirements**

Corrosion plays a large part in the EMD Phase during:

- Development of a system/equipment or increment/upgrade of capability with CPC planning in mind;
- Affordability and protection of critical program/system/equipment infrastructures; and
- Demonstration of the system/equipment integration, interoperability, supportability, safety, and utility.

## **1.2 Planning Actions/Requirements for the Next Milestone**

CPC planning should be a part of the major reviews conducted during the EMD Phase:

- Integrated Baseline Review (IBR);
- Critical Design Review (CDR);
- Test Readiness Review (TRR);
- System Verification Review (SVR);
- Functional Configuration Audit (FCA);
- Production Readiness Review (PRR); and
- Technology Readiness Assessment.

## **2.0 Systems Engineering**

### **2.1 Program Technical Requirements**

Systems Engineering (SE) Execution

- Verify CPC requirements flow-down and translation to requirements, system specifications, and contract language;
- Provide CPC coverage at technical reviews, assessments, and events (e.g., Corrosion Prevention Advisory Board);
- Analyze SE/CPC planning tradeoffs and show life-cycle cost estimates versus major design parameter trades;
- Design system/equipment that will minimize impact of corrosion and materiel deterioration throughout system lifecycle;
- Take action to influence system design based on corrosion reports to reduce/mitigate corrosion risks;
- Identify and mitigate CPC Programmatic Environment, Safety, and Occupational Health Evaluation (PESHE)/Environmental, Safety, Occupational, and Health risks;
- Integrate corrosion SE functions with logistics activities and requirements (e.g., LCSP, Independent Logistics Assessment (ILA), product support Business Case Analysis, (BCA) product support integration and planning); and
- Verify that CPC/SE requirements are incorporated into test activities and functions (e.g., Test and Evaluation Master Plan (TEMP), test result reviews).

SE Planning For P&D Phase

- Identify planning requirements, RFPs, and contracts;

- Review and update corrosion planning documents as needed (e.g., CPCP, AS, LCSP); and
- Validate/update the operational environment/Concept of Operations (CONOPS) understanding of the influence on program/system/equipment corrosion susceptibility and revise CPC accordingly.

#### Legacy Issues

- Describe the use of reliability, availability, and maintainability (RAM); cost data; and lessons learned from legacy system(s); and
- Consult the DoD Cost of Corrosion Studies at [www.corrdefense.org](http://www.corrdefense.org).

#### Capabilities Development Document (CDD)/CONOPS)

- Describe program/system approach for influencing CPC planning requirements in CDD/CONOPS;
- Understand the operational environment and CONOPS and describe how they are going to influence the corrosion susceptibility of the system/equipment;
- Understand how the environmental severity will affect the system/equipment or cause degradation or warranty issues; and
- Develop system/equipment design that will minimize impact of corrosion and materiel deterioration on the system/equipment throughout the lifecycle and impact affordability.

## 2.2 Engineering Resource Management

#### Corrosion Research and Development (R&D)

- Identify how the program/system/equipment will monitor technologies to reduce the cost of corrosion, and implement R&D products and prevention technology and processes;
- Identify how the program/system/equipment will track effects of R&D products on corrosion mitigation and prevention; and
- Identify areas of unique corrosion R&D topic/needs for the system/equipment.

## 2.3 Technical Activities and Products

#### SEP (Changes or Updates)

- Coordinate the CPC planning interface with SE Working-level Integrated Product Team (WIPT) during development of the SEP;
- Ensure the SEP defines how the program will manage CPC planning requirements (e.g., statutory, regulatory, derived, certification);
- Ensure the SEP identifies how the program team will be structured and organized to satisfy CPC requirements;
- Document the program's CPC planning interdependencies in terms of family of systems (FoS) for synchronizations, if applicable;

- Identify CPC planning Human Systems Integration (HSI) initiatives required to optimize total system performance and minimize total ownership cost (TOC);
- Describe how the SEP links SE to other corrosion management efforts (e.g., Technology Development Strategy/AS, test planning, sustainment planning, configuration management, risk management, and lifecycle management); and
- Ensure budget/funding for CPC SE functions are identified and sufficient.

#### Post-Milestone B Preliminary Design Review (PDR)

- Develop a government CPCP and update appropriately;
- Form a Corrosion Prevention Team (CPT);
- The contractor should develop and deliver a contractor version of a CPCP as a CDRL product;
- Address specific specifications and standards for corrosion control materials, preservatives, and systems in the contractor CPC planning documentation;
- Identify concerns of corrosion control processes affecting the environment, as listed in the PESHE;
- Evaluate risks for integrating the proposed corrosion control systems into the system/equipment;
- Address whether the corrosion control system affects other weapon operational concerns;
- Determine if proposed corrosion control products, materials, and systems are currently being manufactured and are available; and
- Ensure that the corrosion control design and manufacturing related to corrosion control are funded and of appropriate duration to support the ongoing EMD Phase.

#### CDR

- Assess CPC in the preliminary materiel solutions that had been developed during the Materiel Solution Analysis Phase; and
- Assess the proposed CPC materiel solution(s), including the corresponding product support concept, that were taken forward to the milestone decision and subsequent Technology Maturation and Risk Reduction (TMRR) Phase.

#### TRR

- Draft corrosion-related requirements for inclusion in the Initial Capabilities Document (ICD);
- Review corrosion strategy links and tangible corrosion-related requirements that are being drafted for inclusion in the ICD;
- In the program/system Analysis of Alternatives, assess CPC and planning for critical technology elements associated with each proposed materiel solution, including technology maturity, integration risk, manufacturing feasibility, and technology maturation and demonstration needs;

- Identify corrosion strategy links and tangible corrosion-related requirements that are being drafted for inclusion in the ICD; and
- Address corrosion risks areas and minimize these risks in the TMRR Phase to ensure a path to full manufacturing capability in the P&D Phase.

#### SVR/FCA/PRR

- Identify full-scale test results that support the program/system/equipment corrosion lifecycle goals and requirements;
- Verify test results that indicate corrosion will not impact materiel availability key performance parameters requirements;
- Verify test results that suggest that the proposed lifecycle sustainment cost of Key System Attributes is accurate concerning CPC costs; and
- Resolve system/equipment CPC issues in all: (a) technical requirements; (b) supporting documentation, including technical manuals and procurement documents; (c) logistics needs; and (d) long-term Operations and Support (O&S) plans.

#### Capabilities Production Document

- Ensure that CPC problems and issues are being tracked, analyzed, and reported;
- Ensure that CPC problems and issues are being resolved; and
- Identify where in the process the SEP for Milestone C is included in the CPC planning and PESHE for program/system/equipment.

### **2.4 Current Milestone Execution Actions/Requirements**

- Design-in critical supportability aspects to ensure materiel availability, with particular attention to reduce corrosion and support the program/system/equipment logistics footprint; and
- Address CPC issues for integrating hardware, software, and human systems; design for producibility.

### **3.0 Life Cycle Logistics**

The Product Support Package element should include CPC planning requirements that are integrated, finalized, and consistent with the approved system design and Product Support Strategy.

- Validate that the design conforms to support requirements for CPC.
- Predict sustainment CPC metrics based on CDR results, the approved Product Support Package element requirements, and projected Supply Chain performance.
- Complete sustainment and product support planning, identifying the sustainment strategy roles, responsibilities, and CPC partnerships that will be implemented.
- Adjust the budget requirements based on the design and test results, including CPC planning.

## **Independent Logistics Assessment**

- ILA-2
- Establish the budget for facilities planning and projects, including CPC requirements and considerations;
- Translate the system design requirements into facilities planning criteria, including CPC requirements and lifecycle considerations;
- Conduct site surveys to ensure that CPC requirements are known and included in the Integrated Logistics Support (ILS)/ILA requirements and system/equipment design and budget—include system/equipment facilities and infrastructure (F&I) interface requirements and issues, including CPC measures;
- Develop system/equipment basic F&I requirements, with CPC requirements included;
- Develop the Facilities Management Plan and include necessary details on CPC and required lifecycle requirements and planning;
- Plan and include in the Program Objectives Memorandum and program the Military Construction (MILCON) and associated sustainment, restoration, and modernization (SRM) requirements, and include CPC planning and requirements;
- Address F&I corrosion issues in the RMP and provide to the ILS/ILA team;
- SMEs review and provide F&I CPC input to the preceding;
- Task the prime contractor to identify required equipment and F&I for the O&S Phase, and include CPC requirements and operations and maintenance guidance for CPC systems/equipment;
- Ensure CPC requirements are included in F&I planning and projects;
- Translate system/equipment design requirements into facilities planning criteria, including CPC requirements;
- Ensure CPC requirements are known and included in the ILS/ILA requirements and budget. MILCON and associated SRM requirements, including CPC considerations, must be planned and programmed into the budget; and
- Ensure the F&I Plan includes CPC requirements.

## **LCSP**

- Continue to identify the mission capabilities taxonomy and metrics driving performance-based outcomes as related to CPC;
- Reassess the availability requirements for the system/equipment to operate successfully in the mission operational environment and the necessary support requirements to achieve objectives, taking into account CPC;
- Redefine the logistics reliability targets and the corresponding sustainment infrastructure necessary to ensure achievement of the reliability objectives as related to CPC;
- Conduct a CPC Planning Review based on the projected maintenance strategy;

- Consider CPC carefully while planning product support implementation to help meet sustainment objectives and requirements;
- Continue refinement of life-cycle cost estimates for CPC;
- Evaluate and update the CPC planning related to performance and acceptance criteria to be demonstrated during planned testing and modeling and simulation;
- Continue refinement of the CPC planning as part of the performance-based logistics (PBL) BCA to determine the:
  - Relative cost versus benefits of different support strategies;
  - Impact and value of cost/performance/schedule/sustainment tradeoffs;
  - Data required to support and justify the PBL strategy.
- Continue refinement of the Product Support Strategy, sustainment funding requirements, key logistics parameters, and logistics testing criteria to optimize CPC;
- Improve CPC planning by continuing to refine the annual determination of the distribution of maintenance workloads due to corrosion; and
- Identify any CPC facilities that are required to support the program, new or existing.

### **3.1 Current Milestone Execution Actions/Requirements**

- Demonstrate that RAM and sustainment features are included in the design of a system/equipment with CPC planning addressed.
- Ensure operational supportability, with particular attention to minimizing corrosion impacts on the system and the logistics footprint.

## **4.0 Test and Evaluation (T&E)**

### **Legacy Issues**

- Make changes or updates based on lessons learned from previous systems/equipment.

### **TEMP**

- Make changes to the planned T&E CPC planning activities for the system's/equipment's lifecycle, and identify areas of concern for the testers; and
- Ensure that each effort has funding for CPC planning.

### **Changes to T&E Assets/Test Methodologies**

- Make changes or updates to CPC planning T&E work/tasks/activities to be accomplished on the system/equipment.

## **5.0 Contracting**

Contract performance requirements are incorporated in RFP, Statements of Work (SOWs), Statement of Objectives (SOO), and Performance Work Statement.

RFP requirements (changes/updates/new) are based upon the acquisition strategy (e.g., sole source, full competition, multi-source procurement):

- Identify the CPC planning requirements in the SOW;
- Develop P&D CDRLs (e.g., finish specification, contractor CPC planning);
- Develop any required CDRLs (finish specification and program/system/equipment CPC planning for contracting efforts);
- Identify any CPC requirements for the system specification;
- Identify changes to specifications and standards; if invoked, define the part, section, or paragraph applicable to the procurement;
- Determine corrosion verification methods (development test/operational test, plan, and prototype testing);
- Consider corrosion prevention opportunities in trade studies;
- Ensure that the CPC strategy is complete and reflected in the RFP;
- Ensure that the P&D contract contains specific requirements for the contractor regarding CPC planning;
- Include corrosion instructions and evaluation factors in Sections L and M of the RFP;
- Ensure that the Systems Engineering Management Plan (SEMP) addresses corrosion planning and corrosion's role in major subsystem design review;
- Determine the program's approach for risk management for CPC (i.e., part of overall RMP, contractor requirements);
- Prioritize program/system/equipment capability gaps based on the CPC planning risk assessment, including areas where additional risks can be accepted;
- Identify corrosion-related risks, create mitigation plans for those risks, and ensure that budget and funding are in place and risks are being tracked;
- For specifications and standards; if invoked, define the part, section, or paragraph applicable to the procurement;
- Identify any required CDRLs (e.g., finish specification and systems CPC planning for contracting efforts, list deliverables, performance standards, and timelines);
- Establish a Contractor Corrosion Team and funding for each prime contractor to participate with a government team, and plan work as described in the draft system/equipment CPCP;
- Identify CPC planning supply/support technical requirements in the SOO/SOW to ensure appropriate data rights language is included in the RFP;
- Identify CPC requirement for SOW;
- Identify changes or updates to CPC planning performance specifications to be incorporated in the RFP to award the initial contract and to procure items;
- Determine bidder expectations from the bidders in the development, implementation, and management of CPC planning;
- Identify changes to CDRLs (finish specification and systems CPC planning for the contractor);
- Identify changes to corrosion performance verification methods

- Determine changes to corrosion-related exit criteria satisfied from PDR.
- Source Selection Evaluation
  - Identify CPC-specific measurable planning criteria for use in evaluating proposals.
- CPC Requirements
  - Determine what specific CPC planning requirements are to be conveyed to prospective contractors.
- Federal Acquisition Requirement (FAR)/Defense FAR Supplement (DFARS) Requirements
  - Identify regulations and legislative requirements the contractors must follow in relation to CPC planning; and
  - Invoke DFARS 48 CFR 223.73 to mitigate risks of hexavalent chromium.
- System Specifications
  - Define the part, section, or paragraph applicable to the procurement, if CPC planning specifications and standards are invoked.
- CDRLs
  - List deliverables, performance standards, and timelines;
  - Determine if a Facilities Requirement Plan will be a CDRL for the contractor and, if so, define.
  - Define required CDRLs (finish specification and systems CPC planning);
  - List data item descriptions to be considered (Government approved):
    - DI-MFFP-81402—*Finish Specification Report*;
    - DI-MFFP-81403—*Corrosion Prevention and Control Plan*
  - Determine requirement for CPT and other meeting minutes; and
  - Ensure DD Form 1423, Block 8 denotes requirement for government approval of deliverables where applicable; and consider adding Director, Corrosion Policy and Oversight, and the Corrosion Control and Prevention Executive to Block 14.
- TOC Metrics
  - Identify CPC planning-related infrastructure and support to equipment (acquisition and central logistics activities), support to military personnel (non-unit central “school-house” training, personnel administration and benefits, and medical care), and support to military bases (installations and communications/information infrastructure); and
  - Identify CPC planning HSI initiatives required to optimize total system performance and minimize TOC.
- Information to Offerors
  - Define CPC planning past performance, qualifications, and training required that the contractor must address; and
  - Determine the test program envisioned by the T&E WIPT, and define the contractor’s role in the testing process.

## **6.0 Cost Estimating and Budget**

Identify new additions or changes to the cost estimate for the program/system/equipment CPC planning efforts that support the level of resources required to develop and procure the system/equipment CPC planning needs.

Identify known funding shortfalls for CPC planning and execution.

### **System Requirements**

- Provide CPC planning cost and funding/budget status, including appropriation, budget activity, system/program element, and the system/equipment name;
- Identify any cost/funding shortfalls for CPC planning; and
- Provide support for technical manuals and maintenance concepts (cost incurred).

### **Contractor Support**

- Identify new additions or changes to contractor support cost/funding and any known shortfalls that may impact CPC planning and execution.

### **Legacy System Costs**

- Ensure new additions or changes to CPC planning-related maintenance costs that have been estimated are based on historical experience/information collected from RAM data, lessons learned, and program data; and
- Consult the DoD Cost of Corrosion Studies at [www.corrdefense.org](http://www.corrdefense.org).

### **IBR**

- Identify changes or updates to historical and prospective CPC drivers of system lifecycle cost that have been quantified to the maximum extent and that the range of uncertainty in these parameters has been captured and reflected in cost estimates;
- Determine Systems Engineering Technical Review entrance and exit requirements consistent with those documented in the current SEP; and
- Ensure the budget contains funding for the SEP processes to address interoperability at the System of Systems and FoS level, testing, systems engineering, risk, prioritization, and configuration management processes that account for performance requirements at the force level.

### **Post-IBR**

- Identify defined CPC-related entry and exit criteria written for CDR;
- Ensure that existing CPC-related RMPs are on track and new risk items are created, funded, and tracked, as needed;
- Ensure alignment with RAM planning;
- Ensure that revised/updated system/equipment contractor CPC planning and government CPC planning are being prepared for Milestone C;

- Ensure that all design decisions impacting CPC are documented with justifications and that RAM planning is updated to account for any changes in inspections and maintenance practices;
- Identify changes or updates to all design CPC planning issues, trade studies, and decisions;
- Identify EMD contractor systems, CPC planning, and finish specification approval or issues;
- Use CPC planning and a PESHE to manage the EMD Phase efforts; and
- Ensure that the contractors SEMP's are aligned and consistent with the SEP.

## ENCLOSURE IV: PRODUCTION AND DEPLOYMENT PHASE

The Production and Deployment (P&D) Phase (Figure 1) is where a program/system that satisfies an operational capability is produced and deployed to an end user. The phase has two major efforts: (1) Low-Rate Initial Production and (2) Full-Rate Production and Deployment. The phase begins after a successful Milestone C review and Engineering, Manufacturing, and Development (EMD) Phase.

**Note:** Please review previous phases for more detailed information if entering at other than pre-Milestone C.

**Note:** If you work through suggested areas in each phase, it should help in development of the Corrosion Prevention and Control Plan (CPCP).

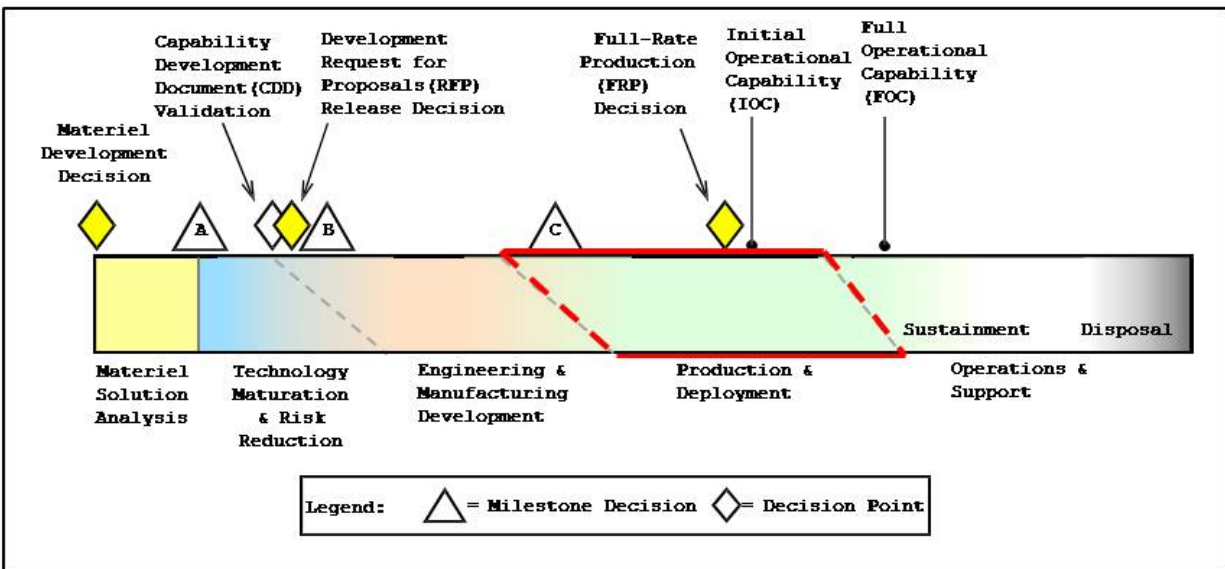


Figure 1: Production and Deployment Phase

## 1.0 Management

Management Structure/Approach: Secure the required corrosion expertise tailored to system/program/equipment needs:

- Ensure Corrosion Prevention and Control (CPC) planning billet(s) are identified to support the Program Management Office (PMO) (e.g., what organization/contractor should provide expertise; what seniority level is to fill the billet(s); whether the billet(s) is currently filled or vacant); and
- Secure CPC personnel with appropriate expertise to oversee CPC planning efforts; and
- Identify funding requirements to ensure that CPC expertise can be assigned to the program team.

Mitigate resource limitations that pose a risk to CPC planning and execution/PMO success.

Early in the lifecycle, identify and assess the program/system/equipment corrosion needs that allow for the formulation of corrosion mitigation approaches and the streamlining of both the program/system/equipment definition and the Request for Proposal (RFP) processes around that critical process.

Identify CPC following any major program/system/equipment change or restructure, such as significant schedule adjustment, requirements change, or scope change to the contract.

Ensure CPC plan execution covers system of systems (SoS) integration points.

Execute and revise Corrosion Prevention and Control Plan (CPCP), as necessary. Update and document in Life-Cycle Sustainment Plan (LCSP).

Execute CPC reporting, Contract Data Requirements List (CDRL), PMO, and Test:

- Determine how the program/system/equipment is going to collect and share information on corrosion within the Department of Defense (DoD) (e.g., lessons learned);
- Manage CPC deficiency report resolutions;
- Develop CPC Quality Program/Qualified Products List; and
- Evaluate contractor personnel qualifications for CPC planning and execution.

Identify resource limitations that pose a risk to CPC planning and execution and PMO success.

Identify whether the system/equipment is developed as stand-alone or is part of an SoS. What is the relationship between this system/equipment and the other systems in relation to CPC planning, post Analysis of Alternatives, interfaces, requirement flow-down systems engineering (SE)?

Document corrosion in the Systems Engineering Plan (SEP), CPCP, LCSP, and others as required.

Establish CPC reporting methods, CDRL, PMO, and Test.

Identify contractor personnel qualifications, as appropriate.

Identify how government/contractor CPC planning and execution minutes and decision reports will be executed.

## **1.1 Current Milestone Execution Actions/Requirements**

During the P&D Phase, CPC planning should:

- Update the product baseline;
- Update the Test and Evaluation Master Plan (TEMP);
- Review risks;
- Update the LCSP;
- Ensure Programmatic Environment, Safety, and Occupational Health Evaluation (PESHE) issues or concerns are addressed for CPC planning;
- Ensure CPC Planning Compliance Schedule for the National Environmental Policy Act is completed;
- Update the SEP;
- Provide inputs to cost and manpower estimate due to the impacts of corrosion; and
- Update the system safety analyses to include finalized hazard analyses.

## **1.2 Planning Actions/Requirements for Next Milestone**

The Technical Reviews that may include CPC planning are:

- Integrated Baseline Review;
- Operational Test Readiness Review (OTRR);
- Physical Configuration Audit; and
- Full-Rate Production Decision Review.

## **2.0 Systems Engineering**

### **2.1 Program Technical Requirements**

Execution of current P&D Phase

- Monitor CPC reporting and corrosion risks and mitigation;
- Ensure mitigation of PESHE/Environmental, Safety, Occupational and Health (ESOH) risks related to CPC;
- Integrate SE functions with logistics activities and requirements (e.g., LCSP, Independent Logistics Assessment (ILA) product support integration and planning);
- Verify CPC requirements with test activities and functions (e.g., TEMP, test result reviews); and
- Ensure that CPC is addressed at Production/Technical Reviews, assessments, and events.

SE Planning for Operations and Support Phase

- Revise CPCP, LCSP, and SEP;
- Validate the operational environment/Concept of Operations, corrosion severity and environmental severity that may affect the program/system/equipment or cause degradation, warranty issues, or influence on corrosion susceptibility;

- Verify corrosion requirements flow-down, translation to requirements, system specification, and contract language;
- Validate that the design will minimize the impact of corrosion and materiel deterioration on the system/equipment throughout the lifecycle and affordability of impacts;
- Integrate CPC planning into the SE processes, including methods for tracking hazards and corrosion risks and developing mitigation plans throughout the lifecycle of system/equipment;
- Integrate SE functions with logistics activities and requirements (e.g., LCSP, ILA, product support blanket purchase agreement, product support integration, and planning);
- Verify CPC requirements with test activities and functions (e.g., TEMP, test result reviews);
- Ensure compliance with PESHE/ESOH responsibilities, requirements, hazard reporting, and mitigation related to CPC;
- Ensure CPC risks areas are addressed in the manufacturing and product support of the system/equipment; and
- Ensure budget/funding for CPC SE functions are identified and sufficient.

#### Planning Requirements for RFPs and Contracts

- Implement CPC mitigation plans to minimize corrosion susceptibility of the system/equipment. Corrosion severity: environmental severity may impact the system/equipment or cause degradation;
- Ensure requirement flow-down has occurred into product support contract language (if any);
- Identify potential CPC capability upgrades;
- Execute CPC planning considerations into SE and product support processes, including methods for tracking hazards, corrosion risks, and developing mitigation plans throughout the lifecycle of the system/equipment; and
- Execute PESHE/ESOH responsibilities related to CPC:
  - Carry out CPC planning integration with ESOH considerations into the SE process;
  - Track corrosion hazards throughout the lifecycle of the program/system/equipment and identify corrosion/ESOH risks and their mitigation status. Minimize or safely dispose of hazardous corrosive materials associated with the system/equipment; and
  - Verify that corrosion risk areas are addressed and minimized in P&D Phase.

#### Legacy Issues

- Describe the use of reliability, availability, and maintainability (RAM) and cost data from the current program and lessons learned from the legacy system(s); and
- Consult the DoD Cost of Corrosion Studies at [www.corrdefense.org](http://www.corrdefense.org).

## **2.2 Engineering Resource Management**

### **Corrosion R&D**

- Describe how the program/system/equipment will track technologies to reduce the cost of corrosion, implement Research and Development (R&D) products, and understand the effects of prevention technology and processes;
- Identify how effects of R&D products on corrosion mitigation and prevention will be tracked; and
- Identify unique corrosion R&D topic/needs areas for the program/system/equipment that minimize changes to a system/program during the build, as necessary.

## **2.3 Technology Activity/Products**

- Identify trade studies;
- Ensure that the contract contains specific requirements for contractor regarding CPC planning;
- Ensure that CPC-related risks are identified and mitigation plans are created, funded, and tracked; and
- Prioritize capability gaps based on the CPC planning risk assessment, including areas where additional risks can be accepted.

### **Development Test/Operational Test**

- Identify corrosion verification methods in plans for prototype testing.

### **OTRR**

- Ensure appropriate CPC test schedules are accomplished;
- Review developmental test and evaluation results to verify they support the corrosion lifecycle goals and requirements and are integrated into the operational test and evaluation (OT&E) process;
- Develop an OT&E process that is suitable to validate CPC requirements per law; and
- Ensure that the Corrosion Prevention Team (CPT) or the program CPC subject matter expert (SME) participates in the tests.

## **3.0 Life Cycle Logistics**

### **Independent Logistics Assessment (ILA)**

#### First ILA in Phase

- Ensure that the design of the new system/equipment is completed and is ready for operational test. Identify issues related to shore interface and supportability risks for this testing. Address CPC planning and related considerations;
- Update the Facilities Management Plan to include CPC considerations, risks, and other issues;

- Ensure that the design for facilities and infrastructure (F&I) includes a lifecycle plan for CPC and that sufficient detail to assist with planning, budgeting, training, and maintenance planning is included in support sustainment, restoration, and modernization (SRM) contracts;
- Provide a representative Product Support Package with CPC planning fielded to support operational test;
- Demonstrate sustainment and product support capabilities (including associated logistics processes and products) through successful CPC tests and demonstrations in an operational environment (if applicable);
- Develop and implement the CPCP to address any issues or weak spots identified in Initial Operational Test and Evaluation by the SME or CPT;
- Measure sustainment and product support for CPC against planned materiel availability, materiel reliability, ownership cost, and other sustainment metrics important to the warfighter;
- Ensure CPC requirements are known and included in the ILA/Integrated Logistics Support (ILS) requirements and budget;
- Identify CPC issues related to sustainability, F&I, and supportability risks;
- Update the F&I Plan to include requirements for CPC;
- Review Military Construction (MILCON) and associated SRM requirements, including CPC considerations to ensure they are planned and programmed into the budget; and
- Review the Risk Management Plan (RMP) to ensure that all corrosion issues (including F&I CPC issues) are evaluated and addressed.

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Second ILA in Phase (if accomplished)

- Ensure that the program/system/equipment design is completed with F&I CPC considerations identified, communicated, and planned for;
- Include all CPC requirements and planning in all details of the shore interface and shore infrastructure requirements;
- Ensure that CPC plans and lifecycle information are identified and included in all supporting projects; and
- Ensure that regional planners and facilities managers are fully aware of all issues related to the program/system/equipment and the F&I interface. Ensure that those same managers are familiar with the lifecycle planning and the CPC plans accompanying documentation associated with the new F&I.

#### Planning

- Ensure CPC requirements are known and included in the ILA/ILS requirements and budget;
- Update the F&I Plan to include requirements for CPC;

- Evaluate CPC plans and accompanying documentation associated with any new facility;
- Review MILCON and associated SRM requirements, including CPC considerations; ensure they are planned and programmed into the budget; and
- Review RMP to ensure all corrosion issues, including F&I CPC issues, are evaluated, mitigated, and tracked.

#### LCSP:

- Emphasize CPC planning and the capability of the sustainment strategy to meet the overall mission capability requirements;
- Evaluate how corrosion is affecting program/system/equipment availability in the mission environment based on current data and update the CPCP to optimize CPC;
- Meet desired metric targets for mission and logistics reliability, including the impact of corrosion, while supporting the achievement of overall system performance objectives;
- Update the CPCP, as necessary, to optimally support the maintenance strategy/plans for sustainability;
- Update both organic and contractor manpower, personnel, and training requirements to support CPC efforts;
- Update the life-cycle cost estimate; validate and refine to support the CPC plan;
- Complete, approve, and fund CPC planning for product support/sustainment approach for the planned product support integrator, product support provider, and warfighter implementation of CPC planning structure, including:
  - Integrator accountability for managing and integrating all support providers to meet established CPC planning requirements; and
  - CPC planning roles, relationships, and functions between program manager, integrator, provider(s) (public/private), and warfighter, including funding.
- Provide a comprehensive review of CPC-related performance and acceptance criteria in a pre-Initial Operational Capability supportability assessment;
- Verify implementation and execution of CPC planning in performance-based logistics (PBL) agreements;
- Update the CPC sustainment criteria and test points in the test and TEMP, if applicable;
- Ensure that CPC planning requirements are supported in PBL agreements (program manager, product support integrator and provider, warfighter); and
- Update CPC-related maintenance costs that have been estimated based on historical experience and from collected RAM data.

## 4.0 Test and Evaluation

### TEMP

- Identify changes to program/system/equipment planned test and evaluation CPC planning activities for the program/system/equipment lifecycle and identify areas of concern for the testers; and

- Provide input to SME/CPT and receive feedback from Follow-on Test and Evaluation.

#### Legacy Issues

- Describe use of RAM data and cost and lessons learned from legacy system(s).

### **5.0 Contracting**

Contract performance requirements are incorporated in RFP, Statements of Work (SOWs), Statement of Objectives (SOO), and Performance Work Statement.

RFP changes, updates/new additions, and requirements based upon acquisition strategy (e.g., sole source, full competition, multisource procurement)

- Establish a Contractor Corrosion Team (CCT) and funding for each prime contractor to participate with a government team and plan work as described in the draft system/equipment CPCP;
- Ensure that data rights for CPC planning supply/support technical requirements in the SOO/SOW are included in the RFP;
- Identify the CPC requirements for the SOW and specification;
- Identify required CDRLs (finish specification and systems CPC planning for contractor);
- Identify CPC requirements for the finish specification;
- Identify changes to specifications and standards; if invoked, define the part, section, or paragraph applicable to the procurement;
- Identify CPC performance verification methods;
- Identify CPC-related exit criteria satisfied from Preliminary Design Review; and
- Determine CPC planning proposal evaluation criteria and specific measurable proposal evaluation criteria; and
- Ensure that the CPC strategy is complete and reflected in the RFP.

#### CPC Requirements

- Relay specific CPC planning requirements to the contractor.

#### Federal Acquisition Requirement (FAR)/Defense FAR Supplement (DFARS) Requirements

- Identify regulations and legislative requirements contractors must follow in relation to CPC planning; and
- Mitigate risks of hexavalent chromium DFARS 48 CFR 223.73.

#### System Specifications

- Define the part, section, or paragraph applicable to the procurement, if CPC planning specifications and standards are to be invoked.

#### CDRLs

- List deliverables, performance standards, and timelines;

- Determine if the Facilities Requirement Plans will be a CDRL for the contractor; and
- Ensure DD Form 1423, Block 8 denotes requirement for government approval of deliverables where applicable; and consider adding Acquisition, Technology, and Logistics/Director, Corrosion Policy and Oversight, and the Corrosion Control and Prevention Executive to Block 14.
- Data Item Descriptions to be considered (Government approved)
  - DI-MFFP-81402—*Finish Specification Report*;
  - DI-MFFP-81403—*Corrosion Prevention and Control Plan*;
- CPT and other meeting minutes; and
- CCT Charter.

#### Total Ownership Cost Metrics

- Identify CPC planning–related infrastructure, support to equipment (acquisition and central logistics activities), support to military personnel (non-unit central “school-house” training, personnel administration and benefits, and medical care), and support to military bases (installations and communications/information infrastructure);
- Determine the CPC planning Human Systems Integration initiatives required to optimize total system performance and minimize total ownership cost.

#### Information to Offerors

- Define the CPC planning past performance, qualifications, and training required that the contractor must address; and
- Determine the test program envisioned by the Test and Evaluation Working-level Integrated Product Team, and define the contractor’s role in the testing process.

#### Sections L and M of the RFP

- Ensure that the Systems Engineering Management Plan addresses corrosion planning and corrosion’s role in major subsystem design reviews;
- Identify the program approach for risk management for CPC (i.e., part of overall RMP, contractor requirements); and
- Prioritize capability gaps based on the CPC planning risk assessment, including areas where additional risks can be accepted.

### **6.0 Cost Estimating and Budget**

- Identify new additions or changes to the cost estimate for CPC planning efforts for the program/system/equipment to support the level of resources required to develop and procure the program CPC planning and execution needs, and
- Identify known funding shortfalls for CPC planning.

#### Program/System/Equipment Requirements

- Identify CPC planning cost and funding/budget status, including appropriation, budget activity, program element, and the program name;
- Identify any cost/funding shortfalls for CPC planning; and
- Determine support for technical manuals and maintenance concepts (cost incurred).

#### Contractor Support

- Identify new additions or changes to contractor support cost/funding and any known shortfalls that may impact CPC planning.

#### Legacy System Costs

- Identify new additions or changes to CPC planning-related maintenance costs that have been estimated based on historical experience collected from RAM data and program data to date.
  - Consult the DoD Cost of Corrosion Studies at [www.corrdefense.org](http://www.corrdefense.org).

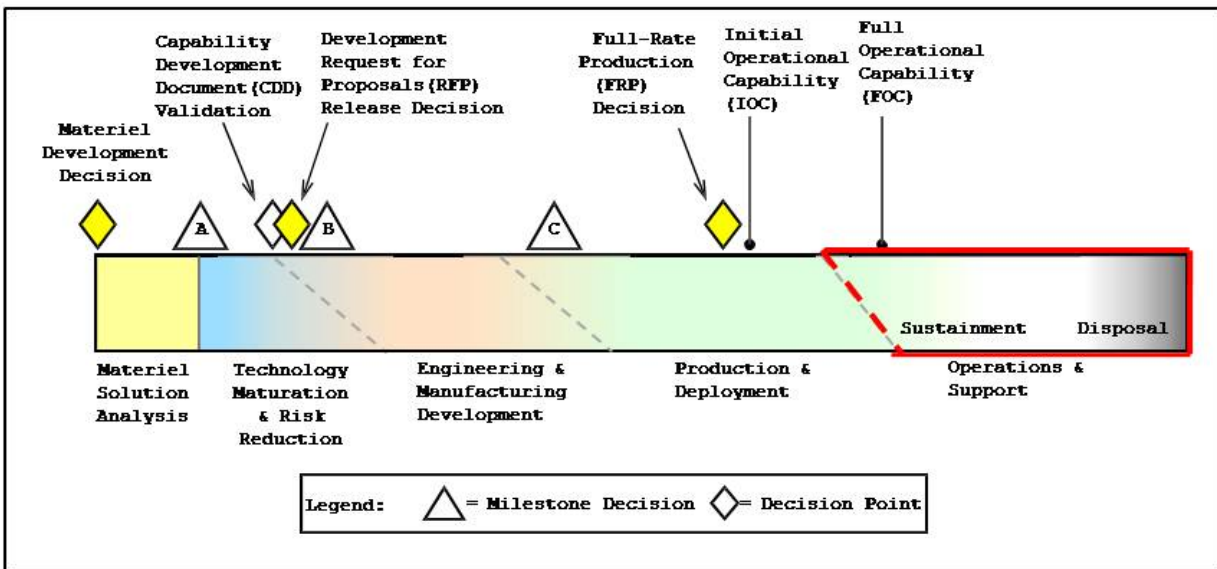
## ENCLOSURE V: OPERATIONS & SUPPORT PHASE

The Operations and Support (O&S) Phase is where a program/system is used and supported by users in the field. The focus on this phase is the execution of a support system that sustains the program/system in the most cost-effective manner possible. The second focus of this phase is the disposal of a program/system when it has reached its useful life.

The O&S Phase identifies root causes and solutions for safety and critical readiness issues. These efforts include participating in trade studies and decision-making relative to changes to the product support package, process improvements, modifications, upgrades, and future increments of the system. All these changes need to consider the operational needs and the remaining expected service life, interoperability or technology improvements, parts or manufacturing obsolescence, aging program/system issues, premature failures, changes in fuel or lubricants, and Joint or service commonality.

**Note:** Please review previous phases for more detailed information if entering at other than Pre-O&S Phase.

**Note:** Working through suggested areas in each phase should help in development of the Corrosion Prevention and Control Plan (CPCP).



*Figure 1: Operations and Support (O&S) Phase*

## 1.0 Management

Management Structure/Approach: Secure the required corrosion expertise tailored to program/system/equipment needs:

- Assure Corrosion Prevention and Control (CPC) planning billet(s) are identified to support the Program Management Office (PMO) (e.g., what organization/contractor should provide expertise; what seniority level is to fill the billet(s); whether the billet(s) is currently filled, or vacant); and
- Secure CPC personnel with appropriate expertise to oversee CPC planning efforts; and
- Identify funding requirements to ensure that CPC expertise can be assigned to the program team.

Provide input into the Management/Sustainment organization chart, including supporting organizations, describing how CPC planning and execution will be accomplished. If available, provide billets and skills necessary to perform the CPC functions.

Early in the lifecycle, identify and assess the program/system/equipment corrosion needs that allows for the formulation of corrosion mitigation approaches and the streamlining of both the program/system/equipment definition and the Request for Proposal (RFP) processes around that critical process.

Identify CPC following any major program/system change or restructure such as a significant schedule adjustment, requirements change, or scope change to the contract.

Identify resource limitations and develop/execute mitigation plans for those areas that affect CPC program.

Update CPC planning and execution strategies for maintenance, major/minor modifications, and technology insertion impacts, such as Diminishing Manufacturing Sources and Material Shortages (DMSMS).

Determine if the program/system/equipment is stand alone, or is it part of a system of systems (SoS).

Determine the relationship between this program/system/equipment and the other programs/systems/equipment in relation to CPC planning and execution. Determine how the organizations will work together to solve interface problems/concerns.

Update and maintain corrosion planning and execution documentation such as the Systems Engineering Plan (SEP), separate Corrosion Prevention and Control Programs, Life-Cycle Sustainment Plan (LCSP), or other appropriate documents.

Describe the CPC reporting methods: Contract Data Requirements List (CDRL), failure reporting, cost estimate impacts, and who and what is reported.

Collect and share information on CPC within the DoD for system improvement (lessons learned).

## **1.1 Current Milestone Execution Actions/Requirements**

Once the fielding efforts are complete, the LCSP describes the actions to be taken to meet the system availability requirements along with CPC planning based on measured performance in the operational environment:

- Identify SE processes for refining the Product Support (PS) Package elements based on operational experience to maintain the program/system/equipment sustainment metrics and control or reduce CPC sustainment costs;
- Provide results of logistics assessments on how the program/system/equipment and supply chain are performing in relation to CPC planning;
- Make adjustments to the PS strategy, including any changes to the Program Office or PS arrangements;
- Determine projected CPC sustainment metric values over the Future Year Defense Plan (FYDP) reflecting the expected results of corrective actions under way;
- Determine required and anticipated CPC funding levels over the FYDP necessary to ensure acceptable affordability and availability rates to maintain mission capability against the relevant threats;
- Provide input to the Capabilities Development Document (CDD) for next increment;
- Make modifications and upgrades to fielded program/system/equipment;
- Provide program/system/equipment safety analyses, including Environmental, Safety, Occupational and Health (ESOH) risk analysis, sustaining hazard analyses for the fielded system, and input to the next increment;
- Provide data for next In-Service Review (ISR);
- Participate in Programmatic Environment, Safety, and Occupational Health Evaluation (PESHE) evaluation; and
- Provide periodic updates to maintenance procedures through reliability-centered maintenance analysis.

## **1.2 Planning Actions/Requirements**

The major review that CPC planning may affect during the O&S Phase is the In-Service Review (ISR).

## **2.0 Systems Engineering**

### **2.1 Program Technical Requirements**

#### **Systems Engineering (SE) Execution of Current O&S Phase**

- Describe how modifications will be implemented in accordance with the CPCP;
- Describe how design changes will be reviewed to address corrosion resistance, including interfaces with other subsystems;
- Monitor corrosion reporting and corrosion risks and mitigation;
- Identify and mitigate PESHE/ESOH risks related to CPC;
- Integrate SE functions with logistics activities and requirements;

- Verify SE requirements with test activities and functions (e.g., Test and Evaluation Master Plan (TEMP), test result reviews);
- Provide corrosion coverage at technical reviews, assessments and events; and
- Perform sustaining engineering CPC planning tradeoff analysis showing how cost varies as the major design parameters and time to complete are traded off against one another.

### **Planning Requirements, Technical/Field Guidance, RFPs, and Contracts**

- Understand the operational environment/Concept of Operations (CONOPS);
- Describe how the operational environment and CONOPS may influence corrosion susceptibility of the program/system/equipment;
- Consider how environmental severity may affect the program/system/equipment or cause degradation or warranty issues;
- Ensure corrosion resistance and maintenance requirements are flowed down and are translated to requirements, statements of work, and/or contract language;
- Consider how cost varies as the major design parameters are changed for modifications from SE CPC planning tradeoff analyses;
- Ensure that CPC is inserted into all levels of maintenance and is reflected in appropriate guidance; and
- Manage hazardous materials and processes associated with CPC in accordance with appropriate planning documentation.

### **Similar Program/System/Equipment Issues and Lessons Learned**

Review lessons learned from similar program/system/equipment to seek common solutions or adopt remedies.

## **2.2 Engineering Resource Management**

### **Corrosion Research and Development**

- Define technology gaps;
- Identify CPC technology improvements and opportunities;
- Describe the process for technology transition and implementation; and
- Describe how inserted technologies will be evaluated for effectiveness during use.

## **2.3 Technology Activity/Products**

### **SEP/LCSP/CPCP**

- Update and maintain the corrosion planning documentation; and
- Ensure budget/funding for CPC SE functions are identified and sufficient.

### **In-Service Reviews (ISR)**

- Demonstrate an understanding of how CPC will be considered during ISRs.

### **PS Business Case Analysis (BCA) and Other Life Cycle Logistics Reviews**

- Ensure technical considerations, field experience, and CPC costs are inserted into sustainment and logistics reviews and activities.

## **2.4 Current Milestone Execution Actions/Requirements**

### **3.0 Life Cycle Logistics**

Refine and adjust PS package and sustainment processes based on performance and evolving operations to include CPC.

Ensure that CPC planning and support systems and services are delivered and fully integrated into the operational environment.

Ensure that Depot CPC maintenance is performed and tracked.

Determine if there are CPC planned improvement, modifications, or upgrades and whether the required documents are also being updated.

Refine the support strategy for CPC leveraging the best-value mix of organic and contractor support.

Ensure that equipment retirement/disposal planning is part of the CPC plan.

### **Independent Logistics Assessment (ILA)**

- ILA-5
- Ensure that the required facilities and infrastructure (F&I) CPC features, plans and budget are in place for the lifecycle;
- Provide as-built drawings and electronic Operations and Maintenance Information (e-OMSI) documentation to the Facility Managers at turnover from the Resident Officer in Charge of Construction (ROICC);
- Contact the CPC subject matter expert (SMEs) for their review CPC features in the designs;
- Ensure that the commissioning program/system/equipment includes commissioning of the CPC features, including testing, documentation, and training of operators;
- Ensure that base maintenance has F&I and the associated new CPC requirements in the support contracts;
- Ensure that the disposal plan for the program/system/equipment and its shore interface is understood, with its possible impacts on CPC planning and execution;
- Ensure that the required F&I CPC features, plans, and budget are in place for the lifecycle phase;
- Review the F&I plan and the requirements for CPC, and update as necessary;
- Ensure that CPC planning related to environmental requirements is known and understood;
- Review Military Construction (MILCON) and associated Sustainment, Restoration, and Modernization (SRM) requirements, including CPC considerations, and update as necessary; ensure any changes are planned and programmed into the budget; and

- Develop the disposal plan for the program/system/equipment and assess the possible impacts on CPC planned execution.

## **LCSP**

- Assess whether the CPC plan and the capability of the sustainment strategy to meet its overall mission capability requirements is being executed as planned; update as necessary;
- Evaluate how corrosion is affecting system availability in the mission environment and update CPC planning as necessary; and
- Validate that actual mission and logistics reliability values, including the affect of corrosion, meet desired metric targets. If targets not being met, analyze and make changes as necessary.

Review Manpower, Personnel, and Training (MP&T) requirements and ensure they support current CPC efforts.

Ensure that CPC planning sustainment criteria are addressed in Follow-On Test and Evaluation (FOT&E).

Assess whether CPC planning requirements are supported in Performance-Based Logistics Agreements, Product Support Integrator and Provider, Warfighter).

Ensure CPC planning is included in the Pre-Initial Operational Capability (IOC) Review.

Validate that actual CPC related maintenance costs that have been estimated based on historical experience collected from reliability, availability, and maintainability (RAM) data; update lifecycle costs as necessary.

## **4.0 Test and Evaluation**

Update, maintain and execute TEMP and field trial/demonstration processes to assure CPC testing is accomplished. Ensure that testing/demonstrations reflect the severity of the operational environment.

## **5.0 Contracting**

Ensure acquisition/contract-related documentation properly establishes requirements for CPC planning and execution and are included in modernization and sustainment contracts, including:

- Statement of Work (SOW), Statement of Objectives (SOO), and Performance Work Statement (PWS);
- Performance/System Specifications (including verification methodology);
  - Assure PHS&T requirements include considerations for CPC;
- DFARS/FAR Requirements;
  - Identify regulations and legislative requirements contractors must follow in relation to CPC planning; and
  - Mitigate risks of hexavalent chromium—DFARS 48 CFR 223.73;
- Data Item Descriptions (DIDs) to be considered (Government-approved);

- DI-MFFP-81402—*Finish Specification Report*;
- DI-MFFP-81403— *Corrosion Prevention and Control Plan*;
- CPT and other meeting minutes;
- Source Selection Evaluation;
  - Determine the CPC Planning Criteria;
- Information to Offerors;
  - Deliver the contractor CPCP.

## **6.0 Cost Estimating and Budget**

Develop and update program/system/equipment cost estimates for CPC to provide rationale for funding requirements.

Plan/acquire funding for CPC efforts.

Identify CPC planning and execution funding shortfalls and related impact.

## APPENDIX I—REFERENCES

- Deputy Under Secretary of Defense for Installations and Environment Memorandum, *Facility Corrosion Prevention and Control*, 10 March 2005
- DoD Corrosion Policy and Oversight Office, *DoD Corrosion Prevention and Mitigation Strategic Plan* (most current)
- DoD Cost of Corrosion Studies, available at [www.corrdefense.org](http://www.corrdefense.org)
- DoD Directive 3020.40, *Defense Critical Infrastructure Program*, 19 August 2005
- DoD Directive 4151.18, *Maintenance of Military Materiel*, 31 March 2004
- DoD Directive 5000.01, *The Defense Acquisition System*, 12 May 2003
- DoD Directive 5134.01, *Under Secretary of Defense for Acquisition, Technology, and Logistics*, 9 December 2005
- DoD Instruction 5000.02, *Operation of the Defense Acquisition System (Interim)*, 26 November 2013
- DoD Instruction 5000.67, *Prevention and Mitigation of Corrosion on DoD Military Equipment Infrastructure*, 1 February 2010
- DoD 8910.1-Manual, *DoD Procedures for Management of Information Requirements*, 30 June 1998
- Section 1105a of Title 31, United States Code, *Budget Contents and Submission to Congress*
- Section 2228 of Title 10, United States Code, *Office of Corrosion Policy and Oversight*
- Section 2366(b) of Title 10, United States Code, *Major Defense Acquisition Programs: Certification Required Before Milestone B Approval*
- Under Secretary of Defense for Acquisition, Technology and Logistics Memorandum, *Corrosion Prevention and Control*, 12 November 2003

## APPENDIX II—ACRONYMS

ACTDs	Advanced Concept Technology Demonstrations
AMMTIAC	Advanced Materials, Manufacturing, and Testing Information Analysis Center
A <sub>o</sub>	Operational Availability
AoA	Analysis of Alternatives
AS	Acquisition Strategy
AT&L	Acquisition, Technology, and Logistics
ATD	Advanced Technology Demonstration
BCA	Business Case Analysis
CAPE	Cost Assessment and Program Evaluation
CCPE	Corrosion Control and Prevention Executive
CCT	Contractor Corrosion Team
CDD	Capabilities Development Document
CDRL	Contract Data Requirements List
CFR	Code of Federal Regulations
CLM	Continuous Learning Module
CLS	Contractor Logistics Support
CM	Configuration Management
CMP	Configuration Management Plan
CONOPS	Concept of Operations
COTS	Commercial off-the-shelf
CPAB	Corrosion Prevention Advisory Board
CPC	Corrosion Prevention and Control
CPCP	Corrosion Prevention and Control Plan
CPD	Capabilities Production Document
CPO	Corrosion Program Office
CPT	Corrosion Prevention Team
CTE	Critical Technology Element
CTMA	Commercial Technologies for Maintenance Activities
DAB	Defense Acquisition Board
DAU	Defense Acquisition University
DFARS	Defense Federal Acquisition Requirements Supplement
DID	Data Item Description
DMSMS	Diminishing Manufacturing Sources and Material Shortages
DoD	Department of Defense
DODD	DoD Directive
DT&E	Developmental Test and Evaluation
DT/OT	Development Test/Operational Test
DTIC	Defense Technical Information Center
EMD	Engineering, Manufacturing, and Development
ESOH	Environmental, Safety, Occupational, and Health
ESTCP	Environmental Security Technology Certification Program
EVMS	Earned Value Management System
F&I	Facilities and infrastructure
FCA	Functional Configuration Audit
FOC	Full Operational Capability
FoS	Family of Systems
FOT&E	Follow-On Test and Evaluation

FRD&R	Full-Rate Production Decision Review
FRP	Full-Rate Production
FYDP	Future Year Defense Plan
GFE	Government-Furnished Equipment
GOTS	Government off-the-shelf
HPT	High-Performance Teams
HQ	Headquarters
HSI	Human Systems Integration
IAC	Information Analysis Center
IAW	In accordance with
IBR	Integrated Baseline Review
ICD	Initial Capabilities Document
ILA	Independent Logistics Assessment
ILS	Integrated Logistics Support
IMS	Integrated Master Schedule
IOC	Initial Operational Capability
IPT	Integrated Product Team
ISR	In-Service Review
ITR	Initial Technical Review
KPP	Key Performance Parameters
KSA	Key System Attributes
LCC	Life-Cycle Cost
LCSP	Life-Cycle Sustainment Plan
LRIP	Low Rate Initial Production
MDA	Milestone Decision Authority
MDACS	Marianas Design and Construction Standards
MILCON	Military Construction
MP&T	Manpower, Personnel, and Training
MSA	Materiel Solution Analysis
NACE	National Association of Corrosion Engineers
NAVFAC	Naval Facilities Engineering Command
NDI	Non-Destructive Inspection
NEPA	National Environmental Policy Act
O&S	Operations and Support
OIPT	Overarching Integrated Product Team
OSD	Office of Secretary of Defense
OT&E	Operational Test and Evaluation
OTRR	Operational Test Readiness Review
P&D	Production and Deployment
PBL	Performance-Based Logistics
PCA	Physical Configuration Audit
PDR	Preliminary Design Review
PESHE	Programmatic Environment, Safety, and Occupational Health Evaluation
PHS&T	Packaging Handling Shipping & Transportation
PM	Program Manager
PMO	Program Management Office
POM	Program Objective Memorandum
PPP	Program Protection Plan
PRR	Program Readiness Review

PS	Product Support
PSM	Product Support Manager
PWS	Performance Work Statement
QA	Quality Assurance
QC	Quality Control
QPL	Qualified Products List
R&D	Research and Development
RAM	Reliability, Availability, and Maintainability
RCM	Reliability-Centered Maintenance
RDT&E	Research, Development, Testing & Evaluation
RFP	Request for Proposals
RMP	Risk Management Plan
ROM	Rough Order of Magnitude
SBIR	Small Business Innovative Research
SEMP	Systems Engineering Management Plan
SEP	Systems Engineering Plan
SERDP	Strategic Environmental Research and Development Program
SETR	Systems Engineering Technical Review
SFR	System Functional Review
SME	Subject Matter Expert
SOO	Statement of Objectives
SoS	System of Systems
SOW	Statement of Work
SRD	System Requirements Document
SRM	Sustainment, Restoration, and Modernization
SRR	System Requirements Review
SSPC	Society For Protective Coatings
STAR	System Threat Assessment
SVR	System Verification Review
T&D	Technology and Development
T&E	Test and Evaluation
TD	Technology Development
TDS	Technology Development Strategy
TEMP	Test and Evaluation Master Plan
TES	Test and Evaluation Strategy
TMRR	Technology Maturation and Risk Reduction
TOC	Total Ownership Cost
TRA	Technology Readiness Assessment
TRR	Test Readiness Review
UFC	Unified Facilities Criteria
UFGS	United Facilities Guide Specifications
USD	Under Secretary of Defense
VE	Value Engineering
WBDG	Whole Building Design Guide
WBS	Work Breakdown Structure
WG	Working Group
WIPT	Working Integrated Product Team

### APPENDIX III—DEFINITIONS

**Acquisition Program**—A directed, funded effort that provides a new, improved, or continuing materiel, weapon or information system, or service capability in response to an approved need.

**Budget**—With respect to a fiscal year, means the budget for that fiscal year that is submitted to Congress by the President under Section 1105(a) of Title 31.

**Component**—A part or combination of parts having a specific function, which can be installed or replaced only as an entity.

**Corrosion**—The deterioration of a material or its properties due to a reaction of that material with its chemical environment.

**Corrosion Prevention and Control**—The processes and techniques that can be implemented to prevent and control corrosion from impacting the availability, cost, and safety of military equipment.

**Corrosion Prevention and Control Plan**—A formal plan, developed and implemented by the Program Manager, to prevent and control corrosion from impacting the availability, cost, and safety of military equipment.

**Corrosion Prevention and Control Planning**—Consists of planning for and establishing 1) a management structure for CPC, and 2) the technical considerations and requirements in order to implement an effective CPC regime throughout the life cycle of a program. CPC planning must include program management, engineering (including systems engineering), life cycle logistics, test and evaluation, budget/funding and contracting. A CPC Plan (CPCP) formally documents the CPC planning and execution, and is updated, refined and matured as the program proceeds through the life cycle phases.

**Defense Budget Materials**—With respect to a fiscal year, means the materials submitted to Congress by the Secretary of Defense in support of the budget for that fiscal year.

**Infrastructure**—Includes all buildings, structures, airfields, port facilities, surface and subterranean utility systems, heating and cooling systems, fuel tanks, pavements, and bridges.

**Military Equipment**—Includes all weapon systems, weapon platforms, vehicles, and munitions of the Department of Defense and the components of such items.

**Subject Matter Expert**—A person who understands, articulates, and implements best practices related to their area of expertise. A subject matter expert has the direct knowledge, skills, abilities, and other characteristics that are required to do the job successfully. Subject matter experts may include those currently doing the job, recent incumbents, those who supervise others doing the job, and other acknowledged job experts.

**Subsystem**—A self-contained system within a larger system.

**System**—A functionally, physically, and/or behaviorally related group of regularly interacting or interdependent elements, with that group of elements forming a unified whole.

## APPENDIX IV—CPC FOR MAIS PROGRAMS

In accordance with Department of Defense Directive (DODD) 5000.01, Department of Defense Instruction (DODI) 5000.02, and DODI 5000.67 requirements, corrosion prevention and control (CPC) planning is required for all critical equipment and infrastructure programs that are subject to harsh environments. The extent of CPC planning varies based on program designation. Acquisition category (ACAT) I programs require formal documentation of CPC planning in a Corrosion Prevention and Control Plan (CPCP) at Milestones B and C.

For Major Automated Information System (MAIS) programs, the following criteria should help to determine the extent of CPC planning required. Programs are expected to determine which criterion is applicable to their program and execute the appropriate level of corrosion planning and documentation.

**Criterion One:** A software-only program is anticipated, not subject to harsh environments.

Program Action: Assure the Systems Engineering Plan (SEP) documents that CPC was considered and as a software-only development, procurement, and/or deployment effort, a full CPCP is not necessary as the result of program not being subject to harsh environments.

**Criterion Two:** Equipment/hardware is to be procured. Equipment/hardware is not to be installed, deployed, stored, or transported in harsh environments. The equipment/hardware is not critical nor does it support a mission-critical program or system.

Program Action: Assure the SEP documents that CPC was considered, and while non-mission critical equipment/hardware is being procured and deployed, the operational, transportation, and storage environment is sufficient and corrosion is not a program risk and equipment/hardware is not subjected to harsh environments. As such, a full CPCP is not necessary.

**Criterion Three:** Equipment/hardware is to be procured and installed, deployed, stored, or transported into harsh environments. The equipment/hardware is mission critical or supports a mission critical program or system.

Program Action: Perform CPC planning and documentation in accordance with DODI 5000.02. Assure Requests for Proposals (RFPs) and contracts support and implement the CPCP.

During the course of SEP reviews, the DoD Corrosion Policy and Oversight (CPO) Office may determine that the applicable criterion is different than that identified by the Program Office. In this case, the DoD CPO Office may require further justification or the development of a stand-alone CPCP by the Program Office.

## APPENDIX V—12 TYPES OF CORROSION

**General Corrosion**, also known as uniform corrosion, occurs when a metal or alloy is placed into a corrosive solution. General corrosion is usually described by the depth of attack over time. It may also be described as a loss in metal thickness or as a rate of penetration where the depth of penetration after a period of time can be estimated.

**Galvanic Corrosion**, as its name implies, is corrosion due to the galvanic action between two or more dissimilar metals, alloys, or electrically conductive nonmetals. This is one of the more common forms of corrosion in complex components because of the wide use of dissimilar metals in the design and manufacture of equipment and structures.

**Pitting Corrosion** occurs on the surface of metals, leaving pits and craters that may rapidly penetrate the metal. In pitting corrosion, the attack is focused at a small area. The surface surrounding the pit might or might not be corroded. Pits can have many shapes. Pit shapes range from broad, shallow pits that are called craters to narrow, deep pits.

**Crevice Corrosion** is localized corrosion that occurs in, or adjacent to, mating surfaces between two metals or between metals and nonmetals such as gaskets. It is similar to pitting corrosion in that it is usually a result of the breakdown of a protective oxide film. Crevices are commonly found at many interfaces between two materials that are not perfectly bonded together such that there may be a very small gap between the two, which is called a crevice. It is within this crevice that water and other chemicals may be tightly held to create a very aggressive chemical environment.

**Dealloying** is the corrosion of one or more of the component metals of an alloy. The remaining material may retain the original size and shape of the alloy but has greatly reduced strength and ductility.

**Intergranular Corrosion** occurs at grain boundaries. Metals and alloys have crystalline structures. This means that the atoms have periodic alignments or stacking of many atoms in atomic planes to make a crystal. Most commonly used alloys are composed of aggregates of small crystals called grains, where one periodic stack of atoms forms a crystal interface with other stacks having slightly different orientations. The resulting aggregate is called a polycrystalline material. The regions where these grains meet are called grain boundaries. These regions can have a different composition and structure than the individual grains themselves. Sometimes this difference in chemistry and structure leads to a more corrosion-prone grain boundary. When corrosion occurs preferentially at the grain boundaries, it is called intergranular corrosion. Exfoliation is intergranular corrosion of an elongated grain structure resulting in a flaking off of the grain layers.

**Stress Corrosion Cracking** is the corrosion-induced propagation of cracks when the material is under tensile stress while being exposed to a corrosive environment. The tensile stress may be due to an applied load, residual stress from forming and fabrication, or a combination of the two. It is particularly insidious because the combined stress and corrosion can cause unexpected structural failure.

**Hydrogen Embrittlement** is the absorption of hydrogen that promotes brittle fracture of the metal crystalline structure. The results of hydrogen embrittlement are various forms of cracking

similar to that encountered in stress corrosion cracking. Cracking can be intergranular or transgranular and is more prevalent in alloys with a high yield strength.

***Corrosion-Fatigue*** is the result of alternating or cyclic stresses of metals in a corrosive environment. A fatigue fracture is usually transgranular—across the grain of a metal.

***Flow-Assisted Corrosion***, or erosion corrosion, occurs or is accelerated when there is relative movement between a metal and its environment, such as the flow of fluids through pipes.

***Fretting*** is direct wear that is due to the motion between two surfaces that are under load and move relative to each other. The relative movement is usually cyclic and occurs at a fairly rapid rate. Fretting of either surface accelerates and increases the effects of corrosion.

***Stray Current Corrosion*** occurs when a metal structure inadvertently gets in the path of current flowing in the environment between two other structures. This type of corrosion can affect most metals buried in soil or immersed in water. Sources of electricity throughout equipment and facilities can provide stray alternating or direct current that may cause corrosion of metal materials in the path of the stray current.

While many contribute to the understanding of the types of corrosion, the above reflect the Corrosion Policy and Oversight Office definitions of corrosion as they pertain to the CPO Mission. The passion of Beau Brinkerhoff to assure full coverage of the corrosion prevention mission is reflected in and honored by this list of definitions.